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"REAL-LIFE" MEASURES OF LEVEL OF ACADEMIC AND VOCATIONAL ASPIRATION IN ADOLESCENTS: RELATION TO LABORATORY MEASURES AND TO ADJUSTMENT[1]

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THE PROBLEM

Since academic and vocational aspirations constitute a highly significant aspect of adolescent goal structure and adjustment, it is important to test the feasibility and predictive usefulness of "real-life" measures of these variables that would be comparable to laboratory measures of level of aspiration. Do such measures have any generality? Are they meaningfully related to indices of adjustment? What relationship do they bear to laboratory measures of aspiration level?

Various investigators have utilized such measures of vocational aspiration as estimate of future income (21, 30), job-prestige level of vocational choice and preference (20, 23), and estimate of past performance in a training situation (18). C. H. Smith (27) measured level of striving in a context of athletic competition. Child and Whiting were concerned with retrospective aspirational responses to every-day experiences of success and failure in the life histories of their subjects (7). The usefulness and the functional relationship of these indices to the more traditional laboratory measures were found to vary considerably. In the present study, a continuum of aspirational measures was employed ranging from concrete and immediate laboratory tasks to more abstract and remote vocational strivings, with academic aspirations and aspirational responses to hypothetical vocational situations occupying an intermediate position.

METHOD

Population

The subjects in this study consisted of 50 students, comprising (with the exception of a few absentees) the entire junior class of University High School[2] in Urbana, Illinois. The mean age of these students was 15.8 years.

[1] This research was supported by grants from the Bureau of Educational Research and from the University Research Board, University of Illinois.

[2] The authors are grateful to Professor C. M. Allen, principal, and to the staff of the University High School, University of Illinois, for their cooperation and administrative assistance in the collection of data for this study.

The distribution by sex was 24 boys and 26 girls. Most of the students come from professional homes, the parents generally holding academic appointments at the University of Illinois.

"Real-Life" Measures of Level of Academic and Vocational Aspiration

Two measures of level of academic aspiration were used: (*a*) *academic goal discrepancy*—the algebraic difference between the student's expressed academic aspirations for the current year and his grade point average for the preceding four semesters; and (*b*) *academic performance estimate*—the algebraic difference between the student's estimate of his cumulative high school standing and his four-semester grade point average. Estimate of high school standing was made on a six point scale ("well below average" to "upper few"), and academic aspiration was expressed in terms of a five point scale ("get by" to "upper few"). Grade point average was computed on a five point scale from actual grades, which in this school are officially recorded but not made known to students.

Three measures of level of vocational aspiration were employed: (*a*) *vocational unreality*—the total discrepancy between each of a subject's nine subscale percentile scores on the Kuder Preference Record (19) and the corresponding mean percentile scores of persons in his occupation of choice as given in the manual for this test; (*b*) *vocational prestige needs*—the student's total weighted score on the level of interests part of the Lee-Thorpe Occupational Interest Inventory[3] (20); (*c*) *vocational tenacity*—a composite standard score on a hypothetical level of aspiration test consisting of three hypothetical situations in which the subject is successively asked to imagine that he is preparing for careers in medicine, engineering, and a skilled trade respectively, and that in the course of his studies he meets serious obstacles of a designated nature. In each situation four alternatives are presented ranging from maintenance of the original goal at all costs (high vocational tenacity) to complete abandonment of the original vocational goal (low vocational tenacity). The subject's choice in each situation, approximately weighted, is converted into a standard score, and all three standard scores are added to yield a composite score.

Laboratory Measures of Level of Aspiration

Five types of laboratory measures of level of aspiration were obtained: (*a*) *composite goal discrepancy*—a total goal discrepancy score derived by adding algebraically the subject's mean goal discrepancy score on each of three paper-and-pencil level of aspiration tests. The mean score for each

[3] In this test, the subject is presented with thirty triads of occupational activities in each of which area of work involved is held relatively constant while level of job prestige is varied. Total score is computed from the subject's preferences in each triad appropriately weighted in terms of job prestige.

test is itself an algebraic mean of S's four goal discrepancies calculated in the usual fashion by subtracting reported score on a given trial from level of aspiration for the immediately succeeding trial. In computing the composite goal discrepancy score, S's mean score for each type of material is first divided by the standard deviation for the entire population. (*b*) *maze goal discrepancy*—the subject's mean goal discrepancy on five trials of a "rigged" stylus maze test. (*c*) *composite goal tenacity*—comparable to the composite goal discrepancy score described above, except that goal tenacity scores are used. Goal tenacity scores are derived by subtracting from each goal discrepancy score the preceding attainment discrepancy. Since the attainment discrepancy (performance on a given trial minus the preceding level of aspiration) is a measure of the feelings of success or failure attending performance (22), the goal tenacity score represents the relative propensity of an individual to maintain a high level of aspiration in relation to prior success or failure experiences. (*d*) *maze goal tenacity*—comparable to composite goal tenacity, except that scores are derived from the "rigged" stylus maze test. (*e*) *initial performance estimate*— a composite discrepancy score on the three paper-and-pencil level of aspiration tests in which S's performance on the first trial is in each case subtracted from his level of aspiration for same. It is a measure of S's degree of optimism relative to future task performance when he has no precise reference point in immediate prior experience to use as a basis for estimating. In computing S's composite score, his scores on the separate test materials are also divided by their respective standard deviations for the entire population of subjects. In a previous study it had been ascertained that goal discrepancy and goal tenacity scores enjoyed relatively high split-half reliabilities and considerable generality over these test materials (2).

Speed of reading (Michigan Speed of Reading Test), speed of addition and subtraction, and speed of digit-symbol substitution were the three types of paper-and-pencil materials used. In each test, the subject makes an initial prediction of performance prior to the first trial and four subsequent predictions following each of the four trials. A trial is defined as a timed interval (60 or 90 seconds) in which S tries to complete as many test units of uniform difficulty as he possibly can.

The "rigged" stylus maze test consists of four "blindfold" trials of an irregular twelve-turn stylus maze. Bogus percentile scores are reported to the subject, and predictions are also made in terms of percentiles. To insure uniform and cumulative experiences of failure for the entire group, the bogus score reported to the subject in a given trial is always a prearranged percentage of expressed level of aspiration (75 per cent for the first trial, and 70 per cent for the next three trials).

To secure ego-involvement in the paper-and-pencil tests, tasks with academic connotations were chosen, and their relevance for academic and vocational success were explicitly pointed out. The stylus maze test was

presented as a measure of learning ability in which the subject's performance was to be related to a group norm.

Measures of Adjustment

The following measures of adjustment level were utilized: (*a*) ***teacher's adjustment rating***—the mean adjustment rating given by five current teachers of each S on a one to five scale. This is a rating of general personality adjustment and was not restricted to the school situation. (*b*) ***anxiety***

TABLE 1

MEANS AND STANDARD DEVIATIONS OF "REAL-LIFE" AND LABORATORY MEASURES OF LEVEL OF ASPIRATION BY SEX GROUPS

	MEAN			STAND. DEVIATION		
Measure	*Boys*	*Girls*	*Significance Level of Difference*	*Boys*	*Girls*	*Significance Level of Difference*
"Real-Life"						
Academic Goal Discrepancy	1.1	1.6	$p>.05$	0.7	1.4	$.05>p>.01$
Academic Performance Estimate	—0.1	+0.7	$p<.01$	0.1	0.2	$p>.05$
Vocational Unreality	9.0	8.6	$p>.05$	2.2	2.8	$p>.05$
Vocational Prestige Needs	62.1	58.4	$p>.05$	5.0	12.4	$p<.01$
Vocational Tenacity	11.4	7.5	$p<.01$	1.9	3.4	$.05>p>.01$
Laboratory						
Composite Goal Discrepancy	—0.5	—1.9	$p>.05$	4.1	3.2	$p>.05$
Composite Goal Tenacity	—0.8	—2.2	$p>.05$	3.2	4.0	$p>.05$
Maze Goal Discrepancy	8.3	7.8	$p>.05$	11.6	12.7	$p>.05$
Maze Goal Tenacity	41.9	43.5	$p>.05$	20.4	24.4	$p>.05$
Initial Performance Estimate ...	—2.6	—3.6	$p>.05$	3.2	1.7	$p<.01$

score—total score on a paper-and-pencil inventory designed to measure anxiety level (Illinois Personality Inventory). (*c*) ***sociometric status***—the mean sociometric rating earned by each student when rated sociometrically by all of his classmates on a five point scale. (*d*) ***M.M.P.I. adjustment score***—total adjustment score on the Minnesota Multiphasic Personality Inventory (13). In deriving total adjustment scores, raw scores of subjects on each of the subscales are first converted into standard scores. Since a positive standard score on a given subscale indicates a degree of deviancy with respect to the trait measured that is greater than the mean characterizing our population, a measure of total personality deviancy is obtained for each subject by summing all of his positive standard scores on the various

subscales.[4] A high total score, therefore, is indicative of relatively poor adjustment.

Results

Table 1 gives separately by sex the means and standard deviations of raw scores on the "real-life" and laboratory measures of level of aspiration. A surprising finding was the significantly greater tendency on the part of girls ($p<.01$) to overestimate their grade point average. The only other significant sex difference between means was in vocational tenacity. As

Table 2

INTERCORRELATIONS AMONG "REAL-LIFE" MEASURES OF LEVEL OF ASPIRATION

Measure	Academic Performance Estimate		Vocational Unreality		Vocational Prestige Needs		Vocational Tenacity	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Academic Goal Discrepancy	**.60	**.87	—.21	—.34	—.22	.06	.10	—.11
Academic Performance Estimate	....	....	—.31	—.11	—.25	—.03	.09	.14
Vocational Unreality	....	....	....	....	**.60	.22	.03	.02
Vocational Prestige Needs	....	....	....	....	....	....	*.44	.08

** Designates significant at the .01 level of confidence.
* Designates significant at the .05 level of confidence.

anticipated, boys showed greater vocational tenacity ($p<.01$). Girls were significantly more variable than boys with respect to academic goal discrepancy, vocational prestige needs, vocational tenacity, and initial performance estimate.

The reliability (test-retest or split-half) of academic goal discrepancy and academic performance estimate scores could not be ascertained; but considerable generality of function with respect to these two measures was reflected in the high correlation between them (see Table 2). Individuals who tended to overestimate past academic accomplishments also tended to have relatively high academic aspirations for the future in terms of past performance. Although academic standing is never officially revealed to students, many cues are apparently available for estimating same since the mean error of estimate of past academic performance was significantly better than chance far beyond the 1 per cent level of confidence.

[4] Since a negative standard score is indicative of deviancy on the masculinity-femininity subscale, negative standard scores on this subscale are added to the other standard scores to obtain the total M.M.P.I. adjustment score.

No feasible method was available for determining the reliability of vocational unreality scores. The test-retest reliability coefficient of the level of interests scores on the Occupational Interest Inventory (identical with our measure of vocational prestige needs) is given as .88 in the test manual (20). Contingency coefficients were calculated between the separate scores on the three parts of the vocational tenacity test. *C* for physician and engineer was .56 ($p<.01$); for engineer and skilled trade, *C* was .25 ($p=.03$); and for physician and skilled trade *C* was —.30 ($p=.02$). Generality of vocational tenacity, therefore, is a function of degree of similarity between

TABLE 3

CORRELATIONS BETWEEN "REAL-LIFE" MEASURES OF LEVEL OF ASPIRATION AND RELATED TEACHERS' RATINGS

"Real-Life" Measures of Level of Aspiration	TEACHERS' RATINGS					
	Scholastic Competitiveness		Persistence		Academic Aspirations	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Academic Goal Discrepancy ...	*—.52	**—.57	*—.57	**—.59	—.30	*—.44
Academic Performance Estimate	—.38	*—.48	—.20	*—.43	—.15	—.31
Vocational Unreality	—.08	.27	—.13	.37	—.03	.33
Vocational Prestige Needs	.31	.23	.16	.11	.35	.25
Vocational Tenacity	.22	*.45	—.04	—.15	.34	.37

** Designates significant at the .01 level of confidence.
* Designates significant at the .05 level of confidence.

occupations on which this measure is obtained. Vocational tenacity in a given hypothetical situation was not enhanced if the subject's actual vocational choice happened to coincide with the goal of the particular hypothetical situation. For example, boys who wanted to be engineers did not make a higher vocational tenacity score on the engineering part of this test than boys who did not express this vocational ambition.

As shown in Table 2, scores on vocational prestige needs were significantly related to both vocational unreality and vocational tenacity in boys. Without exception, academic and vocational measures of level of aspiration were not significantly related.

A very surprising finding was a pronounced tendency for academic goal discrepancy scores (presumably indicative of level of academic aspiration) to correlate negatively with such highly related teachers' ratings as "scholastic competitiveness," "persistence," and "academic aspirations." In other words, students who expressed high academic aspirations tended to be judged by teachers as relatively non-competitive, as possessing low academic

TABLE 4

RELIABILITY OF TEACHERS' RATINGS OF VARIOUS ASPIRATIONAL TRAITS

Aspirational Trait	*Mean Intercorrelation† between Ratings of Five Teachers*
Scholastic Competitiveness	**.50
Academic Aspiration	**.64
Persistence	**.57

† Mean intercorrelations were calculated by the "squared r" method.
** Designates significant at the .01 level of confidence.

aspirations, and as non-persistent in their strivings. The same negative relationship prevailed with respect to academic performance estimate, but was statistically significant in only two of the six instances (see Table 3). In general, the relationships between teachers' ratings and measures of vocational aspiration were not statistically significant and revealed no consistent trend. The teachers' ratings themselves showed a fair amount of reliability (generality over raters) (see Table 4), and considerable generality over traits (see Table 5). Some of this latter generality might in part be a function of "halo effect," but much of it must undoubtedly reflect logical similarity between traits. Table 5 shows that the three motivational traits are more closely related to each other than any of them is to teachers' rating of adjustment.

Laboratory and "real-life" measures of level of aspiration were not significantly related to each other. No consistent pattern of relationships was apparent, and no coefficient of correlation reached the 5 per cent level of confidence when scores were intercorrelated separately for boys and girls.

TABLE 5

INTERCORRELATIONS AMONG PERSONALITY TRAITS AS RATED BY TEACHERS

Personality Trait	*Scholastic Competitiveness*	*Academic Aspiration*	*Persistence*
General Adjustment	**.60	**.42	**.71
Scholastic Competitiveness	....	**.79	**.81
Academic Aspiration	....	....	**.73

** Designates significant at the .01 level of confidence.

TABLE 6

CORRELATIONS BETWEEN "REAL-LIFE" MEASURES OF ASPIRATION AND VARIOUS MEASURES OF ADJUSTMENT

"Real-Life" Measures of Level of Aspiration	Teachers' Rating of Adjustment		Anxiety Level (I. P. I.)		Sociometric Status	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Academic Goal Discrepancy	*—.43	*—.49	**.63	.30	—.09	*—.51
Academic Performance Estimate ..	—.20	*—.46	*.42	.17	—.11	*—.42
Vocational Unreality	—.31	—.22	—.30	—.27	—.16	—.11
Vocational Prestige Needs	—.25	—.10	—.28	.34	—.16	.09
Vocational Tenacity	—.11	.19	.25	.12	.21	.25

** Designates significant at the .01 level of confidence.
* Designates significant at the .05 level of confidence.

High academic goal discrepancy scores (and to a lesser extent academic performance estimate scores) were negatively related to teachers' rating of adjustment in both boys and girls, and to sociometric status in girls (see Table 6). In boys these same measures of level of academic aspiration were positively correlated with anxiety level. Vocational measures of level of aspiration were not significantly related to measures of adjustment. No significant correlations were obtained between M.M.P.I. adjustment scores and any of the "real-life" measures. The split-half reliability coefficients of the anxiety scores and the sociometric status scores were .94 and .90 respectively. The mean intercorrelation[5] between five teachers' ratings of adjustment was .64.

To test the possibility that significant relationships between adjustment scores and "real-life" measures may have been obscured in the correlational analysis as a result of the frequently reported tendency for ***both*** high positive and high negative aspirational scores to be associated with poor adjustment (4, 11, 26), a chi-square test was performed in each case. Upper and lower adjustment groups on each criterion of adjustment were tabulated in relation to upper, middle, and lower thirds of the frequency distributions of the "real-life" measures. Significant values of chi-square were (with only one exception) obtained in only those instances in which significant correlations are shown in Table 6. Inspection of the chi-square tables revealed that the better adjusted (or less anxiety-ridden) subjects tended to make low scores on the aspirational variables in question and *vice versa*. The one exception in which a significant value of chi-square (p=.01) accompanied

[5] The mean intercorrelation was obtained by the "squared r" method.

a non-significant r between the two variables occurred in the case of academic goal discrepancy and M.M.P.I. adjustment scores. Here the majority of the more poorly adjusted individuals obtained goal discrepancy scores in the middle range of the distribution, whereas the majority of the better adjusted subjects obtained low discrepancy scores.

Discussion

The absence of sex differences in favor of boys with respect to mean scores on laboratory and "real-life" measures of level of aspiration (except for the higher mean score of boys on vocational tenacity) goes against the general trend of previous findings (24, 29, 31). It can be accounted for perhaps by the high socio-economic status of our subjects. The vocational interest patterns of girls are in no sense inappropriate for traditionally masculine occupations (6); and girls from upper socio-economic groups are encouraged at the secondary and undergraduate levels of instruction to think in terms of academic and vocational aspirations that are commensurate with those of boys. In Holt's study, Radcliffe women actually made higher goal-discrepancy scores than Harvard men (17). That greater heterogeneity exists in the aspirational patterns of girls—suggestive of greater diversity in cultural expectations—is evident from significantly greater variability in the academic goal discrepancy, vocational prestige needs, vocational tenacity, and initial performance estimate scores of our subjects. Very significantly also, girls manifest less mean vocational tenacity when they are confronted with serious obstructions to hypothetical goals. It can be defensibly argued that their culture permits them to retire more gracefully from the field—with less loss of self-esteem—under adverse conditions of goal striving.

Measures of academic aspirations were found to have generality from past to future estimates as indicated by the high correlation between academic goal discrepancy and academic performance estimate. Hilgard and Sait (16) also found high correlations between discrepancy scores involving estimates of completed and future laboratory tasks respectively. Paradoxically, measures of academic aspiration were negatively related to teachers' judgments of closely related traits. The difficulty of judging aspirational level of others, however, should not be underestimated. Gardner (9) found no significant relationships between laboratory measures of aspiration and eight related personality traits. Ausubel (1) obtained an r of —.09 between pupils' self ratings and teachers' ratings on aspirational traits. In view of the notoriously poor insight of teachers into adolescents' interests (5) and strivings, "real-life" measures of aspirational level are presumably a more valid measure of motivational status than the ratings of teachers who do not happen to be intimately acquainted with the personality structure and development of their pupils.

The test of vocational prestige needs is based on the assumption that by the time individuals reach the age of adolescence they manifest characteristic and stable needs for a given range of occupational prestige. This assumption is supported in part by the high test-retest reliability which this test enjoys (20). Generality on the vocational tenacity test is a function of degree of similarity between occupations. This finding is in accord with the results of previous investigations on level of aspiration for laboratory tasks (2, 14). The measure of vocational unreality is based on the premise that it is unrealistic for individuals to aspire to a given vocation unless they have interest patterns similar to those of persons already employed in their occupation of choice. Insofar as it has been shown that systematic and logically predictable differences exist in the interest patterns of different vocational groups (19, 28), and that the appropriateness of an individual's interest pattern is related to occupational success and contentment (28), this assumption is quite defensible. Supportive evidence for this interpretation is also found in the moderately high correlation obtained in this study between vocational unreality and vocational prestige needs in boys. High needs for prestige may understandably influence an individual to ignore the fact that his interest patterns are inappropriate for the occupation to which he aspires. They would also tend to increase his vocational tenacity (see Table 2).

In contrast to previous findings that *both* high positive and high negative discrepancy scores on laboratory measures are associated with poor adjustment (4, 11, 26), high academic aspirations were found to be inversely related to adjustment in both sexes, directly related to anxiety level in boys, and inversely related to sociometric status in girls. Hence, with respect to long-range, "real-life" goals, only high aspirations have negative implications for adjustment, whereas low aspirations tend to have favorable implications. The finding that high anxiety is associated with high levels of aspiration confirms the results of previous investigations with laboratory measures (3, 8, 12). The sex differences are in the expected direction. The failure of vocational measures of aspiration to correlate significantly with indices of adjustment is attributed to the lack of imminence of vocational problems. In an actual vocational setting Klein (18) found that over-estimates of performance were negatively related to success in flying training.

The most difficult finding of all to explain has to do with the absence of relationship between laboratory and "real-life" measures of level of aspiration. One is tempted at first to accept Hilgard's view that this lack of relationship is a function of the relative triviality and the low degree of ego-involvement characterizing laboratory tasks (15). This could hardly be the entire explanation, however, since laboratory goal discrepancy scores have been found to possess considerable generality over trials within a task and between different tasks (2, 14, 16, 22). Additional evidence of the significance of laboratory measures of aspiration level for general personality structure comes from the findings that high and low goal discrepancy scores

on laboratory tasks are associated with over- and underestimation respectively of own I.Q. (10) and of own sociometric status (25).

Hence, it might be more precise to state that both laboratory and "real-life" measures of level of aspiration can be characterized by ego-involvement, and that the apparent lack of relationship between them is a function of important differences relative to the centrality and reality stratum in which this ego-involvement operates. Laboratory tasks are obviously less threatening to self-esteem, and ego disinvolvement can be effected more easily in relation to them than in relation to "real-life" goals. They are also more immediate, more concrete, and more readily correctible by a tangible and realistic frame of reference in previous performance. "Real-life" aspirations, on the other hand, are relatively remote and hypothetical. Our culture encourages the young to aspire to grandiose and unrealistic goals. The distant future is not bound by the same reality considerations as the immediate present.

But when laboratory or "real-life" measures of level of aspiration are related to indices of adjustment under conditions in which the tasks have relevance for the *current* situation, e.g., academic goal discrepancy, significant relationships between aspirational measures and adjustment are found (see Table 6). Klein's (18) results, already referred to, support this finding. P. S. Sears (26) also found that laboratory measures of aspiration were significantly related to adjustment when the experimental tasks were important in the daily lives of her subjects. When both laboratory and "real-life" measures involve *current* situations at comparable strata of reality testing, e.g., estimates of I.Q., sociometric status, and of immediate performance on school tasks, the two kinds of measures are positively related (10, 25). This relationship is dramatically pointed up by C. H. Smith's finding that immediate but not ultimate level of aspiration in athletic competition is correlated with previous athletic performance (27).

Summary and Conclusions

"Real-life" measures of academic and vocational aspiration were obtained for a class of fifty juniors in a University high school, and related to laboratory measures of level of aspiration and to indices of general adjustment, anxiety level, and sociometric status.

Girls made significantly higher errors of estimate in judging past academic performance and showed significantly greater variability than boys on most "real-life" measures. Boys made significantly higher scores on a measure of vocational tenacity.

Estimates of past academic accomplishment were highly correlated with estimates of future academic performance. Both measures of academic aspiration, however, were negatively correlated with teachers' ratings of related traits. Scores on a test of vocational prestige needs were significantly

related to measures of "vocational unreality" and vocational tenacity in boys. Generality on the vocational tenacity test was a function of degree of similarity between occupations. Academic and vocational measures were not significantly related to each other.

Measures of academic aspiration were negatively correlated with measures of general adjustment in both sexes and with sociometric status in girls. In boys, a significant positive correlation was obtained between magnitude of academic aspiration and anxiety level. Measures of vocational aspiration were not significantly related to indices of adjustment. The feasibility of their use in non-vocational settings is, therefore, questionable.

The obtained absence of significant relationships between "real-life" and laboratory measures of level of aspiration is attributed to greater centrality of ego-involvement in the former, and to differences in the relative corrective influence of reality considerations operating respectively in the immediate present and in the remote future.

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EMOTIONAL DEPENDENCE AND INDEPENDENCE IN A PHYSICAL THREAT SITUATION

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This paper reports an approach to measuring emotional dependence and independence in grade school children responding to a novel situation involving the threat of physical injury. One way in which people depend on others is by seeking reassurance in situations they perceive as threatening to themselves. We assume that a child develops the tendency to look to others for reassurance in threatening situations because others protect him from injury. Thus he learns to associate their presence, their encouraging remarks, or their help with being safe from harm. Thereafter, when he becomes anxious in anticipation of injury, the child may seek reassurance as a means of relieving his anxiety. In a study of children's fears of the dark and of high places, Holmes (2) demonstrated how children may utilize the reassuring presence of an adult as an emotional support in facing feared situations.

A child exhibits independence when physically threatened if he copes with the situation without requiring reassurance or help. It is assumed that he will tend to rely on himself if he expects that he can avoid injury or that he can tolerate whatever injury he may suffer. Also, the child may show independence as a way of winning approval from others, or as a way of avoiding their disapproval. Finally, he may express independence in order to experience the self-approval which comes from knowing that he has mastered a difficult or threatening situation.

METHOD AND SUBJECTS

In selecting a task for measuring dependence and independence under physical threat, six criteria were employed: (*a*) the task should involve the possibility of physical injury which all subjects will perceive; (*b*) it should not be so threatening that any grade school children will refuse to perform it; (*c*) it should be a task which children in the 6-12 age range are capable of performing independently; (*d*) it should be novel in order to minimize differences in the children's experience with similar tasks; (*e*) it should allow a clear choice between dependent and independent modes of coping with it; and (*f*) it should provide a series of trials to permit adjustive changes to be measured.

[1] The writer is grateful to Mrs. Ruth Bean, Edna Small and Suzanne Hamberger for assistance in conducting this study.

The physical threat situation devised for this exploratory study was the Walk-the-Plank Test, a task which meets the six requirements relatively well. In this test, the subject was blindfolded and instructed to walk the length of a plank balanced on springs and raised eight inches off the floor. The plank was six feet long and 12 inches wide, with sideboards rising two inches above the level of the plank to prevent stepping off the side. It was pivoted at the center like a teeter-totter, and was attached at either end to a baseboard by two springs. It required a weight of about sixty pounds applied to the end of the plank to tip it downward until it touched the floor. To add to the instability of the plank, the cross-board on which it was pivoted was an inch higher at the center of the plank than at either side so that the plank tipped sidewise as well as endwise. One foot from the exit end of the plank, a small strip of wood was nailed across it so that the subject, when his foot bumped against the strip, would know he was near the end.

The subject was led into the testing room past the apparatus and seated at a desk facing away from the apparatus. When he went by the apparatus, he was not permitted to inspect it or test it in any way. After he was interviewed for about fifteen minutes in connection with another study, the subject was administered the Walk-the-Plank Test. For this, he was blindfolded with rubber goggles adapted for the purpose, then given the instructions which follow.

"This is a game where you walk along a wiggly board and step down to the floor when you get to the end. (E leads S to starting end of plank.) Step up. (E holds S's arm while S gets into position.) Turn this way. (E exerts pressure to turn S facing toward exit end of plank.) Feel the sides. (If necessary, E helps S bring his feet against both edge boards.) You will know when you get to the end because your toe will bump against a board stretched across the end. Walk between the sides till your toe bumps against the board, then step down to the floor."

"O.K. Do you want me to walk along with you this time?" (E touches back of S's hand and waits for him to accept or reject the help offered. If S takes the hand, E walks beside him to the end of the plank. If he ignores or rejects the hand, E walks silently behind him to catch him if he loses his balance.)

Five trials were given in immediate succession, with the subject led back to the starting end and helped into the starting position after each trial. At the beginning of each trial, the helping hand was offered in the same way and with the same statement as on the first trial. A record was kept of acceptance or rejection of the offer and of the subject's remarks. The reason for limiting the test to five trials was that previous exploratory work with the test indicated that a fair proportion of children become resistant if the number of trials exceeded five or so.

The subjects were 56 children, 31 boys and 25 girls, between six and 12 years of age. All were members of the Fels Research Institute's longitudinal research population which draws almost exclusively from the middle socio-economic class. The writer served as experimenter.

Results

General Reactions to the Test

We may infer that a high proportion of the subjects perceived the task as physically threatening from the fact that two-thirds of them accepted the helping hand on the first trial while, of the remaining one-third, most were obviously tense and cautious while walking the plank. Subjects' spontaneous remarks, such as "It's scary," "I'm afraid I'll fall," and "It feels funny," verbalized the anxiety which they felt while performing the task. A small proportion of the subjects (about one in ten) behaved from the start with calm assurance, walking quickly and confidently along the plank and offering remarks such as "I like it" and "It's fun." Although nearly all of the subjects perceived the task as threatening, none of them refused to perform any of the five trials.

Concerning the novelty of the task, all 56 children reported, when interviewed at the end of the task ,that they had rarely been blindfolded before and never before had walked a springy board when blindfolded. Their experiences with blindfolds had been limited to occasional games of pin-the-tail-on-the-donkey, blind-man's buff, or the like.

The need for reassurance in coping with the situation was shown not only by taking the helping hand but, with several subjects, by leaning toward the experimenter while walking the plank. Some subjects rejected the hand but asked the experimenter to walk along beside them.

In interpreting the independence most subjects showed on the first or later trials, it is important to note that they were never instructed to walk the plank alone. The fact that most did so indicates their own tendencies toward independence, either because they assumed this was expected of them or because they desired to master the task. Typical remarks indicating their desire to perform the task alone were, "I'll try it by myself," "I believe I can," and "I'll do it alone."

Sex Differences

A popular notion is that girls are more fearful than boys in physical threat situations, and more inclined to be dependent on others for protection against injury. The present test offers the opportunity to check this notion in a situation which was highly novel for both the boys and girls who served as subjects.

For the sex comparison, twenty boys and twenty girls were selected from the 56 children on the basis of closest possible age matching. The means

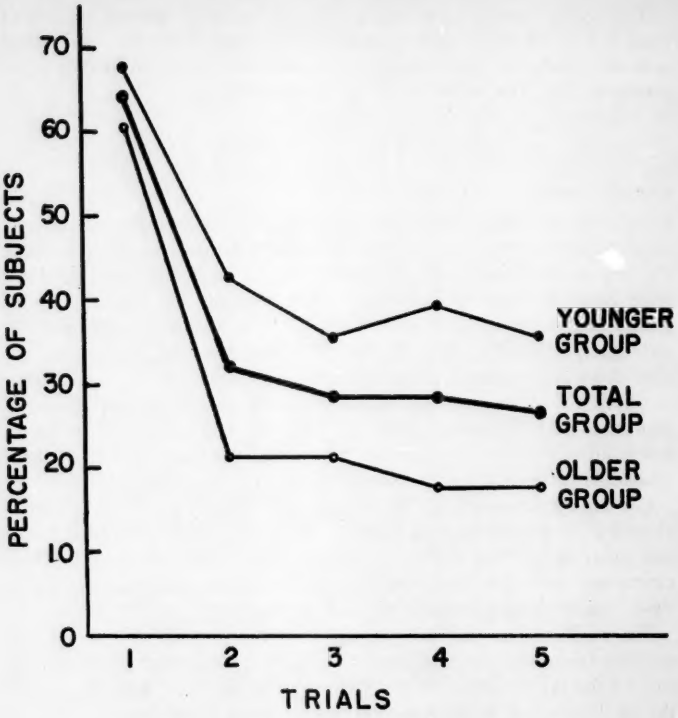

FIGURE 1—Percentages of subjects who accepted the helping hand on each of five trials in the Walk-the-Plank Test. The curves give results for 28 younger and 28 older children and for the total group of 56 children.

of both groups were 121.4 months. The median age of the boys' group was 129 months; of the girls' group, 130 months. Both groups had a semi-interquartile range of 17 months. On the first trial of the test, 12 of the boys and 14 of the girls accepted the helping hand. On all five trials taken together, the twenty boys accepted the helping hand a total of 32 times, the twenty girls also 32 times. The evidence of this study thus failed to support the view that girls are more fearful or less self-reliant than boys in physical threat situations when the factor of experience with the situation is controlled. If the boys did have more experience than the girls in facing physical threats, or if they were generally under more social pressure to exhibit courage, these differences did not generalize to this task.

Trial-to-Trial Differences

The Walk-the-Plank Test confronted the subjects with a situation which was novel in that it required them to walk an unstable platform without visual cues to direct them and to help them keep their balance. While almost all of the subjects were capable of doing the task without help, on Trial 1 they could not be sure of the hazards ahead or of their ability to cope with them. This meant that on Trial 1, anxiety and the associated need for reassurance should have been at a relatively high level, and a higher proportion of subjects would be expected to accept the helping hand on this trial than on later trials. After Trial 1, all the subjects had a more realistic basis for knowing the requirements of the task and for estimating their ability to perform it without aid. From this, it was reasonable to predict a greater decline in the number of subjects accepting the hand on Trial 2 (as compared with Trial 1) than would occur on Trials 3, 4 or 5 as compared to Trials 2, 3 or 4, respectively.

The results strongly supported this prediction. Thirty-six of the 56 subjects accepted the helping hand on Trial 1, 18 on Trial 2, 16 on Trial 3, 16 on Trial 4, and 15 on Trial 5. Figure 1 presents graphically the percentages of the 56 subjects who accepted the hand on each trial (note curve marked "Total Group"). The decline in the proportion of subjects who accepted the hand on Trial 2 as compared with Trial 1 was significant beyond the .01 level.[2] The further declines which occurred on Trials 3 and 5 were not significant.

Ten of the 56 children (six boys and four girls) accepted the hand on all five trials. Their failure to learn to walk without help raises significant questions for independence training in threatening situations. Five of the ten not only held the experimenter's hand but leaned on him as they walked the plank. This meant they were giving themselves no chance to learn to balance themselves and it is not surprising they remained dependent throughout the task. The conditions under which a person "throws away his crutches" in a threat situation is an important research problem.

The fact that nine subjects "regressed" by accepting the helping hand after walking without help on one or more trials indicates a conflict between dependent and independent tendencies. The most likely explanation is that, with these subjects, the experience of walking the plank by themselves increased their anxiety in anticipation of injury to the point where they resorted to help as a way of lessening their anxiety. The Walk-the-Plank Test evidently provides a good situation for further research on dependence-independence conflict directed to the question, "What situational variables

[2] The proportion of subjects accepting the hand in Trial 1 was .643. Using the formula $\sigma_p = \sqrt{pq/N}$, the fiducial limits of $\pm 3\sigma_p$ for the population sampled in Trial 1 are .829 and .457. The proportion of subjects accepting the hand in Trial 2 was .321 which is outside these limits.

determine the choice of dependent or independent responses in a physical threat situation?"

Age Differences

In this study it was assumed that dependent responses (taking the helping hand) indicated relatively high anxiety in anticipation of injury and/or relatively low tendencies to assert independence. By and large, older children were expected to have less anxiety than younger children in a given physical threat situation as a result of their greater capacities. Also, it was assumed that, in this culture, older children would have stronger needs to behave independently than younger children as a reflection of stronger social expectations that they handle situations on their own. These assumptions led to the prediction that older children would be less dependent(or more independent) than younger children in the Walk-the-Plank Test.

Considering that the test was a highly novel situation for the subjects and that none of them could know what to expect until after the first trial, it was predicted that on this trial the older children would express more nearly the same amount of dependence as younger children than would be true on later trials. In other words, it was assumed that the older subjects would be unable to utilize fully the advantages their greater capacities and experience gave them until they knew what the task required of them.

The age differences obtained support the analysis given above. The 56 children were divided into younger and older groups of 28 each. The younger group ranged from 80 to 114 months of age with a median age of 98 months, the older group from 114 to 150 months with a median age of 134 months. On trial 1, 19 of the younger and 17 of the older children accepted the helping hand. Thus, on the initial trial, age differences were at a minimum. On later trials, age differences were larger. On Trials 2, 3, 4 and 5, respectively, the numbers of younger children accepting the helping hand were 12, 10, 11 and 10. Corresponding numbers of older children were 6, 6, 5 and 5. These results are presented graphically in Figure 1. Another indication of age differences in the task was the fact that, of the ten children who accepted help on all five trials, eight were in the younger group.

While the age-differences found in this study were consistent with theoretical expectations, the data were insufficient to yield statistically significant differences.

Mothers' Behavior in Relation to Dependence-Independence

It is generally assumed that a child's parents play critical roles in determining his ways of dealing with problem situations. At the Fels Research Institute, data on the mothers' ways of relating to their children are available in the form of periodic ratings using the Fels Parent Behavior

Rating Scales. These thirty scales deal with various aspects of mothers' behavior toward their children. The ratings are made following a visit to the home by the Fels Home Visitor who observes the mothers' interaction with her children. These ratings offer the basis for an exploratory test of the relationships between certain aspects of mothers' behavior and the dependence-independence behavior of their children in the Walk-the-Plank Test.

Five of the 30 aspects of mothers' behavior rated in the Scales were selected on theoretical grounds as having particular relevance for learning to express dependent or independent tendencies in physical threat situations. These are Child-centeredness of Home, General Babying, Protectiveness, Accelerational Attempt, and Democracy of Policy. These scales have been described in detail by Baldwin, Kalhorn and Breese (1). They are characterized in briefest terms in this report.

High child-centeredness of the home means that the household revolves around the children, with major sacrifices made for the children's trivial comforts. Low child-centeredness means that the children's welfare is subordinated to that of other family members, with the children being left largely to fend for themselves. It was predicted that high child-centeredness would be associated with high dependence in the Walk-the-Plank Test on the assumption that it encourages the child to lean on others rather than taking care of himself in problem situations.

High babying means that the child is continually helped, even when he is fully capable of doing things by himself. Low babying means the child is left alone to solve his problems, and is often refused aid when he asks for it. It was predicted that high babying would be associated with high dependence in the Walk-the-Plank Test.

High protectiveness means that the child is sheltered from discomforts and difficulties, while low protectiveness means he is deliberately exposed to hazards or dangers. It was predicted that high protectiveness would be associated with high dependence on the Walk-the-Plank Test.

High acceleration means that the child is deliberately trained to develop skills, while low acceleration means he is held back from "growing up." It was predicted that high acceleration would be associated with high independence on the Walk-the-Plank Test on the assumption that acceleration involves training for mastery of situations.

High democracy of policy means that a child is given a definite share in deciding policies which concern him, while low democracy means that he is dictated to without regard to his own wishes. It was predicted that high democracy would be associated with high independence, assuming that it fosters self-reliance and discourages passive dependence.

To test the predictions, only the results for Trial 1 of the Walk-the-Plank Test were used. On later trials, too few subjects accepted the helping hand to permit adequate statistical analysis of differences between those subjects

who accepted and those who rejected the helping hand. On Trial 1, thirty-six subjects accepted help and twenty rejected it. From the thirty-six who accepted help, twenty were selected strictly on the basis of choosing the group which most closely matched, in terms of sex and age, the group of twenty subjects who rejected help. Both groups contained 11 boys and nine girls. The Dependent Group (composed of subjects who accepted help) had a mean age of 119.9 months, the Independent Group (composed of subjects who rejected help) a mean age of 119.6 months. As further evidence that the groups were satisfactorily matched in terms of age, the Dependent Group had a median age of 124.5 months and a semi-interquartile range of 17.2 months, while the Independent Group had a median age of 127.0 months and a semi-interquartile range of 19.3 months.

In selecting ratings for use in this study, those made following the last home visit prior to the time the child was given the Walk-the-Plank Test were used. Since home visits are not conducted with children past the age of (approximately) ten years, the interval between the time the ratings were made and the time the data of this study were obtained was almost three years for some of the older subjects. The mean interval for the forty subjects involved in this part of the study was 18.3 months. With 63 per cent of the subjects, the interval was between 11 and 15 months; with eight per cent, between 16 and 24 months; and with 29 per cent, between 25 and 34 months. If one makes the plausible assumption that there is marked consistency from year to year in a mother's way of relating to her children, the time discrepancy should not render the home visit ratings selected inapplicable to the purpose of exploring relationships between mothers' behavior and the subjects' performance of the Walk-the-Plank Test.

The home visit ratings used were in the form of T-Scores, which place the individual in relation to other children in the Fels research population. A rating of 50 thus places the child at the mean of the norming group, a rating of 40 places him one sigma below the mean, while a rating of 60 places him one sigma above the mean. In comparing the parent-behavior ratings given children in the Dependent and Independent Groups, the mean T-Scores were computed for each group for each of the five mother-behavior variables. The reliabilities of differences in means of the Dependent and the Independent Groups were determined using Wilcoxon's non-parametric test for unpaired replicates (3).

Table 1 summarizes the results obtained with each of the five variables. It was predicted that high child-centeredness, high babying and high protectiveness would be associated with dependence rather than independence in the Walk-the-Plank Test. The results for child-centeredness and babying were in the predicted direction, though babying did not yield a significant difference. With protectiveness, a slight and insignificant difference was found in the opposite direction from that predicted. This finding may re-

flect unreliability of the measures employed, or it may indicate that the prediction made with respect to the protectiveness variable was incorrect.

It was predicted that high acceleration and high democracy would be associated with independence in the Walk-the-Plank Test. The results with both variables were in the predicted direction, though the difference in means was not significant with respect to democracy.

The results of this analysis support the view that a child's behavior in a physical threat situation is related to certain aspects of his mother's behavior toward him. Further research is needed to establish the nature and

TABLE 1

MEAN RATINGS ON FIVE MOTHER-BEHAVIOR VARIABLES FOR 20 SUBJECTS WHO ACCEPTED THE HELPING HAND (DEPENDENT GROUP) AND 20 SUBJECTS WHO REJECTED THE HELPING HAND (INDEPENDENT GROUP) ON TRIAL 1 OF THE WALK-THE-PLANK TEST

Mother-Behavior Variable	*Mean of Dependent Group*	*Mean of Independent Group*	*Difference*	*Predicted Direction?*	*Reliability*
Child-centeredness ...	51.8	44.6	+7.2	Yes	<.02
Babying	47.6	44.0	+3.6	Yes	Non-signif.
Protectiveness	48.7	49.8	−1.1	No	Non-signif.
Acceleration	48.4	54.0	−5.6	Yes	<.05
Democracy	47.6	51.3	−3.4	Yes	Non-signif.

degrees of such relationships because of several limitations of this exploratory analysis. The results presented here involved too few subjects to be conclusive with some of the variables employed. The ratings of mothers' behavior used may be unrepresentative because they were based on a single home visit and because they were made from one to three years prior to the subjects' performance of the Walk-the-Plank Test. Also, no measure of the reliability of the Walk-the-Plank Test was available.

It should be noted that differences in mothers' behavior toward the children in the Dependent and the Independent Groups may reasonably be interpreted in two ways. It may be that a mother influences her child's performance in threat situations by indulging him or coaching him, or it may be that the child's behavior in problem situations influences the way his mother treats him. For example, a child may be fearful and dependent because his mother babies him, or his mother may baby him because he is fearful and dependent. Thus the data of this study do not permit determining whether the mother's behavior or the child's behavior was the independent variable.

Discussion

The Walk-the-Plank Test is a promising technique for investigating dependent and independent responses to physical threat in grade school children. The task is threatening enough to arouse marked anxiety and to induce a high percentage of children to seek reassurance, particularly on the initial trial. At the same time it is not so threatening or so difficult that children as young as six years of age cannot perform it independently. The blindfold, in combination with the raised and unstable platform, offers a highly novel situation for children in the age range studied. Acceptance or rejection of the helping hand offers a clear differentiation of dependent and independent modes of coping with the task. The task as designed for this study is not well suited for studying individual adjustment to threats because, with most subjects, adjustment occurs within a trial or two. Also, the all-or-none measurement of dependent and independent responses does not permit ranking individuals in terms of fine differences in their adjustive responses to the situation. For these reasons, the task is primarily of value in differentiating groups of subjects in terms of dependent and independent behavior.

A major limitation of the task as employed in this study is that no measure was obtained of the amount of threat the subject perceived in the situation, or the amount of tension or anxiety it aroused. If measures of autonomic arousal or verbal reports of anxiety were obtained on each trial, dependent and independent modes of response could be interpreted more meaningfully. The task would probably be improved by blindfolding the subjects before they saw the apparatus. Also, it would probably be an improvement to reduce the instability of the plank since this would place less emphasis on differences in the subjects' skills in maintaining balance.

In considering further studies for which the Walk-the-Plank Test is suited, the investigation of factors which affect the shift from dependent to independent modes of coping with the situation seems particularly promising. Thus different techniques of offering reassurance might be employed with comparable groups of subjects. A comparison of the groups on, say, the fifth trial of the test would indicate the relative effects of the different techniques employed. Similarly, one group of subjects might be offered reassurance and help on each trial and another group required to perform the task on a "sink-or-swim" basis without any form of support. Also, the test lends itself to study of the effects of social factors such as the presence of one's parents or one's peers on performance of the task.

Summary

1. This paper reports an exploratory study of emotional dependence and independence in the Walk-the-Plank Test which required the subject while blindfolded to walk the length of a six-foot plank balanced by springs

and raised eight inches off the floor. Fifty-six children, 31 boys and 25 girls, between six and 12 years of age individually performed five trials on the apparatus. On each trial, the subject might exhibit dependence by holding the experimenter's hand while he walked the plank, or he might exhibit independence by walking the plank without help.

2. Evidence was presented to indicate that almost all of the subjects perceived the task as threatening. However, the task was not so threatening that any of the subjects refused to perform any of the five trials.

3. No sex differences were found in the subjects' performance of the Walk-the-Plank Test.

4. Two-thirds of the subjects accepted the helping hand on the first trial of the test and approximately one-third on each of the succeeding four trials. The difference in the proportion of subjects accepting the helping hand on Trials 1 and 2 was significant. The fact that a very high proportion of the shifts from dependence to independence occurred on the second trial was interpreted as related to the novelty of the task on the first trial.

5. Almost the same proportion of younger and older children accepted the helping hand on the first trial of the test. However, on later trials, the younger children accepted the helping hand twice as often as the older children. The lack of evidence for age differences on Trial 1 was interpreted as related to the novelty of the task on that trial.

6. There was evidence that the amount of dependence or independence children showed in the Walk-the-Plank Test was related to certain aspects of their mothers' behavior toward them at home as rated with the Fels Parent Behavior Rating Scales.

7. The Walk-the-Plank Test was discussed in relation to its suitability for use with further studies of dependence and independence.

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THE PROTEIN, CALCIUM, PHOSPHORUS, AND MAGNESIUM CONTENT OF NURSERY SCHOOL LUNCHES INCLUDING "SECONDS"

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A knowledge of the composition of nursery-school meals is of importance if the daily intake is to be adequate. Studies of this nature are few; estimated values rather than determined ones are given. Two studies made of the North Texas State College Nursery School meals have been published; the first (7) determined the vitamin A and ascorbic acid of the noon meal plus fluid milk and mid-morning fruit juice; the preformed vitamin A alone was in excess of the National Research Council's recommended daily allowance for this age group while the ascorbic acid provided one half of the day's requirement. The second study (3) determined the nitrogen, calcium and phosphorus content of similar meals. Nitrogen expressed as protein provided 14 to 22 per cent of the recommended allowance for this age group, 24 to 34 per cent of the calcium, and 21 to 27 per cent of the phosphorus. Each child was permitted as many "seconds" as he desired provided he had consumed all of the original food given him. Records were kept of the number and kind of "seconds" consumed by each child but the composition of these foods was not determined. The authors of these studies commented on the need for such analyses in order to obtain a true picture of the nutrients furnished by the nursery school lunches. Consequently, the present study was undertaken to determine the range of protein, calcium, phosphorus and magnesium provided the children when the "seconds" of the best and poorest eater in each age group were also analyzed.

PROCEDURE

Ten noon lunches (mid-morning fruit juice, composite food and fluid milk) and the daily "seconds" of a best and a poorest eater from both the younger and the older age group of children were analyzed for nitrogen during the summer of 1952 and for calcium, phosphorus, and magnesium during the summer of 1953. The technique of collecting and preserving a serving of food from each group as well as the sampling of the mid-morning fruit juice and fluid milk was previously reported (7). The

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"seconds" of the best and poorest eater from each age group were obtained in duplicate at the time the child was served. The values of the "seconds" when added to the value of the composite food and fluid milk gave the range of nutrients consumed by each age group.

The macro-Kjeldahl method was used in determining the nitrogen of the samples and converted to protein for comparison with the National Research Council's recommended daily allowance for these age groups. The calcium, phosphorus, and magnesium content of these same samples were determined gravimetrically (5, 8).

Results

Since the original servings of the day's composite food and fluid milk had been found earlier (3) to be low in protein, an attempt was made to increase the protein content of the present lunches by substituting and by supplementing the recipes with a protein concentrate (MPF), Formula B.[2] During periods II and III the menus were identical but the MPF was used as a substitute for the cereal, meat, or cheese during period II, while it was used as an added supplement to these same recipes during period III. It is evident (Table 1) that the average protein intake for period III, 6.05 gm., is slightly larger than the 5.21 gm. for the same menus (period II) with the MPF substituted for part of the cereal, meat or cheese. It is also evident that the average for period I, during which there was no planned substitution or additive use of MPF, was almost as great, 5.97 gm., as that with the MPF added as a supplement, 6.05 gm. The amount and kind of protein foods served seem to determine the total protein of the composite food plus milk values rather than either the substitution or addition of the protein concentrate used.

This is also evident under the heading of the best eater of the younger group whose "seconds" increased his average daily intake of protein by 2.72, 1.82 and 2.52 gm. during the three periods of the study. The poorest eater in this group consumed a great many "seconds" of meat balls the first day of period I, which accounts for his only high "seconds" during the three periods.

The best eater had "seconds" of both composite foods and milk each day while the poorest eater had no "seconds" of either composite foods or milk on three days, and only composite "seconds" or milk "seconds" on four other days, leaving three days on which he had "seconds" of both composite foods and fluid milk. The protein intake of the poorest and best eaters of the younger group provided 8.10 and 12.30, 7.25 and 10.52, and

[2] Multi-Purpose Food, Formula B, ingredients: soy grits, salt, fortified with calcium pyrophosphate, kelp, vitamin A ester, irradiated ergosterol, vitamin B_1, Riboflavin (B_2), and niacinamide. This was obtained from Meals for Millions, Foundation Incorporated, 648 South Broadway, Los Angeles 14, California.

8.86 and 11.90 gm. for periods I, II, and III, respectively. In other words, the best eaters received about one and one-half times as much protein from their noon lunches as did the poorest eaters.

For each period (Table 2) the older group of children were given slightly larger servings of each food which resulted in a slightly higher intake of

TABLE 1

TOTAL PROTEIN CONTENT OF THE LUNCHES EATEN BY THE BEST AND POOREST EATERS OF THE YOUNGER GROUP DURING EACH OF THE THREE PERIODS STUDIED

		Grams Protein from Composite Food Plus Milk and "Seconds"							
		Best Eater				Poorest Eater			
Periods	*Days*	*Composite Food Plus Milk*	*Seconds of Composite Food**	*Seconds of Milk*	*Total*	*Composite Food Plus Milk*	*Seconds of Composite Food**	*Seconds of Milk*	*Total*
I	1	7.02	4.61	2.34	13.97	7.02	4.17†	0.00	11.19
	2	4.77	2.15	2.91	9.83	4.77	0.00	0.00	4.77
	3	6.56	2.97	2.34	11.87	6.56	0.00	0.00	6.56
	4	5.54	4.71	3.27	13.52	5.54	0.00	4.36	9.90
	Ave.	5.97	3.61	2.72	12.30	5.97	1.04	1.09	8.10
II	1	5.75	4.46	2.18	12.39	5.75	1.62	2.18	9.55
	2	4.74	2.07	1.09	7.90	4.74	0.15	0.00	4.89
	3	5.15	3.95	2.18	11.28	5.15	0.00	2.18	7.33
	Ave.	5.21	3.49	1.82	10.52	5.21	0.59	1.45	7.25
III	1	6.12	3.94	2.52	12.58	6.12	1.74	2.52	10.38
	2	5.35	3.21	2.52	11.08	5.35	0.00	0.00	5.35
	3	6.67	2.84	2.52	12.03	6.67	1.65	2.52	10.84
	Ave.	6.05	3.33	2.52	11.90	6.05	1.13	1.68	8.86

* While "seconds" varied in size the portion analyzed in each case was identical for the specific "seconds" taken by the child.

† Milk "second" was put in with the food.

protein from composite foods plus milk. The best and the poorest eaters from this age group consumed almost the same amount of protein daily during this study. In fact, during period II the poorest eater consumed more protein rich foods than did the best eater. The poorest eater of this group had "seconds" every day of composite food and of milk every day but one. The protein intake for the poorest and best eaters of the older group was 11.35 and 11.33, 9.65 and 8.25 and 11.44 and 10.80 gm. for periods I, II, and III respectively.

TABLE 2

TOTAL PROTEIN CONTENT OF THE LUNCHES EATEN BY THE BEST AND POOREST EATERS OF THE OLDER GROUP DURING EACH OF THE THREE PERIODS STUDIED

		Grams Protein from Composite Food Plus Milk and "Seconds"							
		Best Eater				Poorest Eater			
Periods	*Days*	*Composite Food Plus Milk*	*Seconds of Composite Food**	*Seconds of Milk*	*Total*	*Composite Food Plus Milk**	*Seconds of Composite Food**	*Seconds of Milk*	*Total*
I	1	7.15	3.86	4.68	15.69	7.15	6.94	2.34	16.43
	2	5.02	2.15	2.34	9.51	5.02	4.51	2.34	11.87
	3	6.16	0.00	2.34	8.50	6.16	.40	2.34	8.90
	4	5.71	1.54	4.36	11.61	5.71	1.40	1.09	8.20
	Ave.	6.01	1.89	3.43	11.33	6.01	3.31	2.03	11.35
II	1	5.82	2.19	2.18	10.19	5.82	6.76	1.09	13.67
	2	5.46	1.67	2.18	9.31	5.46	1.57	0.00	7.03
	3	5.25	0.00	0.00	5.25	5.25	0.81	2.18	8.24
	Ave.	5.51	1.29	1.45	8.25	5.51	3.05	1.09	9.65
III	1	7.00	2.23	2.52	11.75	7.00	2.96	2.52	12.48
	2	6.00	1.54	2.52	10.06	6.00	0.51	2.52	9.03
	3	6.19	1.88	2.52	10.59	6.19	1.08	2.52	9.79
	Ave.	6.40	1.88	2.52	10.80	6.40	1.52	2.52	10.44

* While "seconds" varied in size the portion analyzed in each case was identical for the specific "seconds" taken by the child.

The calcium, phosphorus and magnesium (Table 3) content of composite food plus milk, "seconds" and totals for the best and poorest eater of the younger group are given. The initial composite food plus milk values 442, 263, and 91 mg. of calcium, phosphorus and of magnesium were increased by "seconds" of 60, 31, and 13, to 502, 294, and 104 mg. for the best eater, while the poorest eater only increased his by 11, 4, and 5 mg. to 453, 267 and 97 mg. per meal.

Similar data are given for the best and poorest eater of the older age group (Table 4). The original servings of composite food and milk furnished the older group more calcium, and magnesium but with slightly less of phosphorus, than that of the younger group. The slight difference of the latter could be due to the difference in composition of a serving of one of the composite foods, especially since many of their composite foods were dishes made of several combinations, as macaroni and cheese, meat loaf, cheese sauce on rice, spaghetti and meat balls, and the like. In all

instances, the poorest eater in the older group consumed fewer "seconds" than did the best eater; with the result that his "seconds" contributed only 10, 3, and 2 mg. as compared with 91, 90, and 21 mg. of calcium, phosphorus and magnesium contributed by the "seconds" of the best eater. Consequently, the average total daily intake of calcium, phosphorus and magnesium 550, 349, and 122 mg., of the best eater is greater than that of the poorest eater who consumed 470, 262, and 102 mg. of these elements.

TABLE 3

CALCIUM, PHOSPHORUS AND MAGNESIUM CONTENT OF COMPOSITE FOOD PLUS FLUID MILK AND "SECONDS" CONSUMED BY THE YOUNGER GROUP

	Calcium			Phosphorus			Magnesium		
Day	*Composite Plus Milk* mg	*Seconds* mg	*Total* mg	*Composite Plus Milk* mg	*Seconds* mg	*Total* mg	*Composite Plus Milk* mg	*Seconds* mg	*Total* mg
"Best":									
1 ...	541	93	643	265	67	332	111	67	178
2 ...	460	79	539	307	43	350	107	16	123
3 ...	395	180	575	202	84	286	65	9	74
4 ...	381	88	469	184	78	262	66	12	78
5 ...	565	..	565	435	..	435	117	..	117
6 ...	490	32*	522	243	8	251	80	5*	85
7 ...	403	32*	435	288	8	296	79	5*	84
8 ...	315	32*	237	158	8	166	83	5*	88
9 ...	428	32*	460	271	8	279	114	5*	119
10 ...	441	32*	473	275	8	283	92	5*	97
Ave. .	442	60	502	263	31	294	91	13	104
"Poorest":									
1 ...	541	108	649	265	40	305	111	54	165
2 ...	460	..	460	307	..	307	107	..	107
3 ...	395	..	395	202	..	202	65	..	65
4 ...	391	..	381	184	..	184	66	..	66
5 ...	565	..	565	435	..	435	117	..	117
6 ...	490	..	490	243	..	243	80	..	80
7 ...	403	..	403	288	..	288	79	..	79
8 ...	315	..	315	158	..	158	83	..	83
9 ...	428	..	428	271	..	271	114	..	114
10 ...	441	..	441	275	..	275	92	..	92
Ave. .	442	11	453	263	4	267	91	5	97

* Since these "seconds" were so small, a composite sample was made.

TABLE 4

CALCIUM, PHOSPHORUS AND MAGNESIUM CONTENT OF COMPOSITE FOOD PLUS FLUID MILK AND "SECONDS" CONSUMED BY THE OLDER GROUP

	Calcium			Phosphorus			Magnesium		
Day	*Total Lunch and Milk* mg	*Food Seconds* mg	*Total* mg	*Total Lunch and Milk* mg	*Food Seconds* mg	*Total* mg	*Total Lunch and Milk* mg	*Food Seconds* mg	*Total* mg
"Best":									
1 ...	532	184	716	252	48	300	81	24	105
2 ...	489	53	542	274	64	338	155	23	178
3 ...	402	172	574	205	120	325	66	15	81
4 ...	405	83	488	228	86	314	67	21	88
5 ...	627	..	627	374	..	374	132	..	132
6 ...	446	83	529	264	116	380	84	26	110
7 ...	443	83	526	273	116	389	112	26	138
8 ...	314	83	397	163	116	279	100	26	126
9 ...	490	83	573	299	116	415	121	26	147
10 ...	446	83	529	263	116	379	91	26	117
Ave. .	459	91	550	260	90	349	101	21	122
"Poorest":									
1 ...	532	103	635	252	25	277	81	16	97
2 ...	489	..	489	274	..	274	155	..	155
3 ...	402	..	402	205	..	205	66	..	66
4 ...	402	..	402	228	..	288	67	..	67
5 ...	627	..	627	374	..	374	132	..	132
6 ...	446	..	446	264	..	264	84	..	84
7 ...	443	..	443	273	..	273	112	..	112
8 ...	314	..	314	163	..	163	100	..	100
9 ...	490	..	490	299	..	299	121	..	121
10 ...	446	..	446	263	..	263	91	..	91
Ave. .	459	10	470	260	3	262	101	2	102

The National Research Council recommends a daily allowance of protein for these age groups of 40 and 50 gm. for the younger and older groups, respectively. The nursery school lunches analyzed, including "seconds," provided about one fifth of the recommended amount for the poorest eater of the younger group, while the best eater of the younger group received one third of this daily allowance. A recent study (1) revealed that 50 per cent of the children of the study had a daily protein intake below that rec-

ommended by the National Research Council. The lowest total intakes averaged 25 gm. of protein per day for children between the ages of 32 and 59 months which includes the age range of the children in the present study. The protein intake of the present study seems low when compared with the National Research Council's recommended daily allowance but it is in line with this recent study (1) furnishing one third to one half of the amount consumed by 50 per cent of these chidren.

The National Research Council recommends a daily allowance of 1 gram of calcium, assuming that if the calcium need is met that the one for phosphorus will also be met. All of the children of the present study received about one half of this amount of calcium. The poorest eater of both the younger and the older groups lacked less than .05 gm. of consuming this amount while the best eaters of each group consumed slightly more than half of a gram of calcium. The phosphorus values of these nursery school lunches do not provide enough phosphorus although the calcium is adequate. Sherman and Hawley (6) state that one quart of milk or one gram each of calcium and of phosphorus are deemed necessary per child per day. Only the best eater of the older group received more than a third of a gram of phosphorus. It is believed that this lower phosphorus is associated with the lower total protein intake since the calcium provided was adequate.

The magnesium requirements have been studied to a lesser degree than those of calcium and of phosphorus. This may in part be accounted for by the many interfering substances present in food which make the chemical analysis of magnesium difficult (4). The most extensive study, Daniels (2), calculated the magnesium intake of three preschool age boys on basis of their body weight and found that they ranged from 198 to 273 mg. per day. Using this as the standard for the present study, since the age ranges are the same, all of the children in the present study received 50 per cent or more of this amount of magnesium in their noon meal.

One may summarize these findings with the statement that the lunches provided an adequate amount of both calcium and magnesium but an inadequate amount of protein and of phosphorus. To improve the intake of the latter two, the protein rich foods, other than fluid milk, should be increased.

Summary

The nursery school lunches analyzed, including "seconds," for a best and a poorest eater in each age group provided an average of 11.57 and 8.07 gm. protein for the younger group and 10.13 and 10.48 gm. for the older group.

The foods supplied to all of the children about one half of a gram of calcium but only one third of a gram of phosphorus.

The magnesium supplied ranged from 98 to 122 mg. It is assumed that this amount represents about one half of a daily requirement of this age group.

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THE EFFECT OF NUTRITIVE FAILURE ON THE GROWTH PATTERNS OF WHITE CHILDREN IN ALABAMA[1]

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Optimal conditions throughout the growing period allow a child to reach the maximum physical development compatible with his heredity. In each child, physical growth must be completed within the limits set by time. Thus the attainment of maximum physical development depends upon a child's ability to remove any accumulated growth debt before the epiphyses and diaphyses of the major long bones undergo fusion.

Chronic nutritive failure as a predisposing cause of growth lag in children has been under study at the Nutrition Clinic of the Hillman Hospital, Birmingham, Alabama, since 1941 (1, 3, 4, 6, 7). During the past decade the growth patterns of more than three thousand children with and without nutritive failure have been investigated. In evaluating growth progress in terms of increases in height and body weight, use was made of the Wetzel Grid and of the height and weight standards developed by Simmons from normal Cleveland children (5, 8). It was postulated that any error inherent in comparing the heights and weights of homogeneous groups of Alabama children to standards derived from a homogeneous group of Ohio children would be relatively constant. While this procedure was adequate for the determination of the relative effects of chronic nutritive failure on the height and weight progress of growing children, it did not provide the absolute values essential for a complete analysis. Accordingly, an investigation was devised whereby the growth patterns of children with chronic nutritive failure have been compared to a standard of reference developed from data obtained in the same geographic area from an ethnically identical group of children without nutritive failure.

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TABLE 1

MEAN HEIGHTS OF TEST AND CONTROL CHILDREN

	BOYS							GIRLS						
	TEST			CONTROL				TEST			CONTROL			
Age (Yrs.-Mos.)	*No. of Cases*	*Mean Height* (Inches)	*S.D.**	*No. of Cases*	*Mean Height* (Inches)	*S.D.**	*Diff. in Means*	*No. of Cases*	*Mean Height* (Inches)	*S.D.**	*No. of Cases*	*Mean Height* (Inches)	*S.D.**	*Diff. in Means*
3—0	26	35.73	1.67	5	38.93	1.84	3.20	15	35.49	2.29	7	36.53	1.79	1.04
3—3	28	36.51	1.66	10	39.56	2.89	3.05	26	36.44	2.20	9	38.26	2.41	1.82
3—6	28	37.33	2.06	9	39.29	2.56	1.96	29	37.22	1.98	10	38.26	1.88	1.04
3—9	34	37.62	2.10	20	40.55	2.45	2.93	31	36.66	3.47	10	39.27	1.56	2.61
4—0	42	38.59	2.25	18	40.63	2.75	2.04	43	37.47	3.35	23	40.20	1.93	2.73
4—3	32	39.05	2.11	19	41.85	1.95	2.80	43	39.38	3.14	20	40.82	2.01	1.44
4—6	37	39.89	1.43	13	42.52	1.85	2.63	35	39.69	2.48	22	41.63	2.93	1.94
4—9	41	40.74	1.93	17	43.81	3.31	3.07	45	40.98	2.45	20	42.81	2.62	1.83
5—0	35	41.57	1.88	14	43.00	4.24	1.43	35	41.20	2.60	20	42.43	2.54	1.23
5—3	43	41.69	2.38	17	45.00	2.56	3.31	63	42.01	4.08	16	43.62	3.35	1.61
5—6	44	42.41	2.27	19	46.20	3.67	3.79	56	42.02	2.49	14	44.50	3.61	2.48
5—9	52	43.35	2.45	25	45.23	2.79	1.88	53	43.02	2.88	15	45.11	2.66	2.09
6—0	56	43.71	2.50	29	45.32	3.09	1.16	59	44.11	3.96	29	45.71	2.60	1.60
6—3	52	44.14	2.72	43	46.95	2.44	2.81	67	44.52	2.91	36	45.99	3.54	1.47
6—6	47	43.94	2.93	28	46.74	2.68	2.80	65	44.58	2.61	33	46.70	3.20	2.12
6—9	58	45.49	2.84	46	47.87	3.66	2.38	63	45.45	2.74	28	46.82	2.66	1.37
7—0	66	45.67	3.09	32	48.44	2.80	2.77	60	46.29	3.25	28	46.97	3.88	0.68
7—3	78	47.52	3.11	33	49.15	3.16	1.63	78	47.21	3.35	27	47.28	3.24	0.07
7—6	77	47.46	2.60	30	49.12	3.26	1.66	73	47.56	3.13	34	48.98	4.00	1.42
7—9	80	48.02	2.48	32	49.60	4.07	1.58	79	47.78	3.35	25	48.72	4.06	0.94
8—0	83	48.65	2.59	39	50.65	3.13	2.00	88	48.44	2.91	50	50.05	3.88	1.61
8—3	74	49.15	2.70	41	51.16	3.65	2.01	93	49.09	2.72	34	50.80	3.08	1.71

8—6	74	49.62	2.84	38	51.57	3.99	1.95	82	49.45	2.87	32	50.79	3.20	1.34
8—9	70	50.17	2.70	28	52.64	4.39	2.47	79	50.04	3.34	28	51.90	3.10	1.86
9—0	89	50.94	3.18	31	52.46	3.91	1.52	91	50.51	3.56	23	52.31	3.98	1.80
9—3	72	51.00	2.58	21	53.66	2.89	2.66	98	51.21	3.16	27	52.46	3.68	1.25
9—6	89	51.79	3.08	28	53.10	3.70	1.31	71	51.87	4.29	31	53.43	3.48	1.56
9—9	76	52.37	3.58	26	54.22	4.19	1.85	98	52.17	4.25	20	53.26	3.95	1.09
10—0	81	52.40	3.55	31	54.25	3.62	1.85	93	52.65	3.55	29	54.55	3.94	1.90
10—3	66	53.21	3.55	21	55.20	1.00	1.99	102	53.22	4.29	39	54.95	4.35	1.73
10—6	70	53.50	3.64	29	55.39	4.02	1.89	93	53.01	3.62	28	55.36	3.54	2.35
10—9	78	53.83	2.69	26	56.05	3.86	2.22	91	54.16	3.44	22	55.51	4.27	1.35
11—0	85	54.84	3.46	24	56.71	6.16	1.87	97	54.93	3.56	26	57.08	4.28	2.15
11—3	62	54.89	3.72	27	56.90	4.07	2.01	85	54.94	3.60	33	57.56	4.72	2.62
11—6	66	55.83	4.41	24	57.32	4.11	1.49	84	55.94	3.28	33	58.04	4.50	2.10
11—9	68	55.79	3.51	22	57.55	3.82	1.76	70	56.81	3.87	29	59.47	3.86	2.66
12—0	55	56.60	4.27	24	57.71	4.41	1.11	80	57.12	3.62	43	59.90	2.79	2.78
12—3	64	56.64	3.56	24	59.16	4.09	2.52	72	57.80	4.33	30	60.54	4.18	2.74
12—6	52	57.10	4.09	28	59.49	4.66	2.39	64	58.15	4.97	46	60.41	4.31	2.26
12—9	56	57.86	4.44	18	60.36	4.61	2.50	56	59.27	4.51	32	60.02	4.88	0.75
13—0	49	58.84	4.13	11	60.45	4.05	1.61	58	59.30	4.14	27	61.28	3.91	1.98
13—3	37	59.12	5.15	28	62.66	8.16	3.54	42	59.24	3.73	29	62.63	3.21	3.39
13—6	46	59.89	4.26	22	62.39	4.17	2.50	47	60.75	4.32	27	62.56	3.53	1.81
13—9	32	59.57	4.50	23	62.73	6.66	3.16	53	60.73	3.08	29	62.31	3.56	1.58
14—0	38	59.41	3.90	27	65.02	8.35	5.61	38	60.98	3.42	37	62.92	3.36	1.94
14—3	43	60.66	4.51	32	65.43	3.83	4.77	41	61.38	3.70	46	63.34	3.42	1.96
14—6	37	61.20	4.51	33	66.04	4.94	4.84	29	59.83	4.50	38	62.76	3.04	2.93
14—9	24	61.94	4.67	38	65.54	4.52	3.60	43	61.89	2.64	45	63.38	3.19	1.49
15—0	26	62.89	5.41	47	66.97	4.64	4.08	29	61.08	3.24	33	64.26	2.91	3.18
15—3	15	62.38	4.54	45	66.16	5.04	3.78	26	62.69	2.74	35	62.90	3.78	0.21
15—6	20	64.47	3.67	43	67.33	4.32	2.86	24	62.34	3.99	39	63.55	3.74	1.21
15—9	15	64.13	3.43	43	66.81	4.56	2.68	17	61.81	3.55	34	63.36	2.86	1.55

• *S.D.* = Standard Deviation.

Materials and Methods

A total of 2404 children without evidence of nutritive failure served as the reference group (control group). Of these, 1182 were boys and 1222 were girls. The group with chronic nutritive failure (test group) consisted of 561 children of which 267 were boys and 294 were girls. Each child was white, of Anglo-Saxon extraction and a resident of the Birmingham district. The groups ranged in age from 2 years 11 months to 15 years 11 months. Height and weight measurements of each child were made by staff members of the Nutrition Clinic by the method described in a previous publication (2).

In compiling the height and weight curves for each sex in each group, mean values were calculated for each 3-month interval between 3 years 0 months and 15 years 9 months. To derive these means, the readings for each child whose chronological age fell within plus/minus one month of a quarter, half, three-quarters and a full year were combined. The reference curves and the curves for the group with nutritive failure were developed from 2853 and 5921 measurements respectively. Of these, 1401 were for boys in the reference group, 1452 for girls in the reference group, 2769 for boys with nutritive failure and 3152 for girls with nutritive failure. The distribution of readings for each sex in each group at each 3-month interval is shown in Tables 1 and 2. The standard deviation indicative of the average deviation from the mean, and the coefficient of variation which relates the measure of dispersion to the mean were calculated for height and weight at each 3-month interval.

The mean speed of growth of each group was determined by converting the height and weight values for each sex at each 3-month interval into isodevelopmental levels by the techniques developed by Wetzel (9). The mean isodevelopmental levels and their standard deviations were plotted on a Wetzel Grid. The resulting curves permitted a comparison of: (*a*) the mean speed of growth of the reference group as contrasted with that of the Wetzel "normal," and (*b*) the mean speed of growth of the group with nutritive failure as contrasted with that of the reference group.

Comparison of the Mean Height Progress of White Alabama Children With and Without Nutritive Failure

The mean height values and standard deviations are presented in Table 1. The coefficients of variation ranged from 3.9 per cent to 13.0 per cent with a mean of 7.0 per cent for the children in the control group and from 3.6 per cent to 9.7 per cent with a mean of 6.4 per cent for the children with nutritive failure. The relatively low coefficients of variation are indicative of a narrow dispersion of individual values about the means in each group at each age.

The mean heights of the control children exceeded those of the undernourished group at each 3-month interval except at 7 years 3 months when

the values for the two groups of girls were identical. The average height difference throughout the age range under investigation was 2.42 inches for the boys and 1.77 inches for the girls. The range for the boys extended from a mean of 1.11 inches at 12 years to 5.61 inches at 14 years; for the girls from a mean of 0 inches at 7 years 3 months to 3.60 inches at 13 years 3 months. The maximum mean height reached by the boys with nutritive failure was 64.5 inches at 15 years 6 months, a value attained by the boys in the control group at 14 years 0 months. The girls with nutritive failure achieved their maximum mean height of 62.7 inches at 15 years 3 months; the control girls reached this value at 14 years 0 months.

The mean height curves of the control boys and the undernourished boys showed a close parallelism between 3 years and 13 years of age, followed by a divergence which reached a peak at 14 years of age. The corresponding curves for the girls were parallel between 3 years and 6 years of age. From 6 years of age to 7 years 3 months, the curves converged, culminating in identical values at the latter age. The curves underwent a progressive divergence from 7 years 3 months to 15 years and converged thereafter. With the exception of ages 3 years to 5 years 6 months in the boys, the mean height curves of the control children fell within plus one standard deviation of the mean height values of the undernourished children. Conversely, and with a similar exception, the mean height curves of the undernourished children fell within minus one standard deviation of the mean height values of the control children.

Comparison of the Mean Weight Progress of White Alabama Children With and Without Nutritive Failure

The mean weight values and standard deviations are shown in Table 2. The coefficients of variation ranged from 4.6 per cent to 25.5 per cent with a mean of 14.4 per cent for the control children and from 5.1 per cent to 19.5 per cent with a mean of 11.4 per cent for the children with nutritive failure. These values are indicative of a substantially greater dispersion of individual weight values about the means than was noted for the height readings.

The mean weight values of the control children exceeded those of the children with nutritive failure at each 3-month age interval. The mean weight differentials for the boys ranged from 2.43 pounds at 3 years 6 months to 33.9 pounds at 15 years 3 months; those for the girls ranged from 0.49 pounds at 3 years to 23.7 pounds at 13 years 3 months. The mean weight differentials at each age interval were 12.74 pounds for the boys and 11.34 pounds for the girls. The boys with nutritive failure attained their maximum mean weight of 111 pounds at 15 years 9 months of age. The control boys reached this value at 13 years 6 months. The maximum mean weight achieved by the girls with nutritive failure was

TABLE 2

MEAN WEIGHTS OF TEST AND CONTROL CHILDREN

	BOYS							GIRLS						
	TEST			CONTROL				TEST			CONTROL			
Age (Yrs.-Mos.)	No. of Cases	Mean Weight (Pounds)	S.D.*	No. of Cases	Mean Weight (Pounds)	S.D.*	Diff. in Means	No. of Cases	Mean Weight (Pounds)	S.D.*	No. of Cases	Mean Weight (Pounds)	S.D.*	Diff. in Means
3—0	26	31.01	1.86	5	35.30	1.61	4.29	15	28.62	1.80	7	29.11	1.73	0.49
3—3	28	32.41	2.58	10	35.08	4.76	2.67	26	31.06	2.75	9	33.41	3.49	2.35
3—6	28	32.82	3.07	9	35.25	2.26	2.43	29	31.03	2.98	10	33.57	2.61	2.54
3—9	34	33.65	3.08	20	39.38	4.03	5.73	31	32.21	2.96	10	35.70	4.26	3.49
4—0	42	34.63	3.99	18	39.30	3.90	4.67	43	33.12	2.93	23	36.18	2.90	3.06
4—3	32	35.48	3.01	19	42.34	4.06	6.86	43	34.24	4.25	20	37.62	3.96	3.38
4—6	37	36.58	3.19	13	42.50	5.40	5.92	35	34.12	5.93	22	39.29	4.47	5.17
4—9	41	37.95	3.17	17	43.63	5.85	5.68	45	36.08	3.62	20	40.97	4.37	4.89
5—0	35	39.00	6.07	14	44.92	4.48	5.92	35	36.25	3.32	20	40.57	5.31	4.32
5—3	43	38.44	3.48	17	46.73	5.27	8.29	63	37.85	3.58	16	41.99	3.80	4.14
5—6	44	40.78	3.54	19	46.78	4.07	6.00	56	37.76	3.52	14	44.00	6.94	6.24
5—9	52	41.68	3.94	25	46.90	6.84	5.22	53	39.30	4.49	15	45.69	5.04	6.39
6—0	56	42.08	3.75	29	46.66	4.74	4.58	59	40.75	4.45	29	48.68	6.64	7.93
6—3	52	43.12	4.36	43	50.30	4.37	7.18	67	42.11	4.36	36	46.95	6.31	4.84
6—6	47	44.37	4.26	28	49.49	7.05	5.12	65	41.59	4.14	33	49.28	6.61	7.69
6—9	58	45.45	4.87	46	51.83	7.31	6.38	63	43.71	4.79	28	48.53	4.24	4.82
7—0	66	47.86	4.33	32	55.61	5.65	7.75	60	45.19	6.26	28	50.88	5.95	5.69
7—3	78	48.77	5.17	33	54.99	6.21	6.22	78	46.78	5.99	27	51.24	7.63	4.46
7—6	77	49.23	4.95	30	56.39	10.06	7.16	73	48.20	5.12	34	54.84	9.85	6.64
7—9	80	51.61	4.52	32	58.95	9.31	7.34	79	48.60	6.17	25	54.52	8.30	5.92
8—0	83	52.29	4.55	39	60.78	6.40	8.49	88	49.83	5.27	50	58.38	9.39	8.55
8—3	74	53.52	5.91	41	61.53	8.39	8.01	93	51.89	6.94	34	61.21	11.55	9.32

8—6	74	54.41	5.62	38	62.42	10.10	8.01	82	52.03	6.48	32	62.23	11.48	10.20
8—9	70	56.42	4.80	28	65.98	12.12	9.56	79	53.87	6.83	28	65.92	10.81	12.05
9—0	89	57.54	5.94	31	66.05	9.94	8.51	91	54.49	7.33	23	68.97	13.36	14.48
9—3	72	57.40	6.18	21	70.56	10.69	13.16	98	56.83	8.29	27	64.78	8.79	7.95
9—6	89	60.25	8.22	28	70.18	12.92	9.93	71	57.58	7.16	31	68.35	11.94	10.77
9—9	76	61.88	7.90	26	72.38	12.48	10.50	98	59.49	7.22	20	69.10	9.44	9.61
10—0	81	62.36	7.65	31	72.92	10.19	10.56	93	60.47	7.80	29	77.41	12.64	16.94
10—3	66	64.08	7.44	21	74.81	7.84	10.73	102	62.17	8.84	39	77.23	14.66	15.06
10—6	70	64.94	8.62	29	75.11	12.71	10.17	93	63.33	8.97	28	80.39	17.64	17.06
10—9	78	66.67	9.72	26	77.82	12.51	11.15	91	65.91	8.62	22	78.84	13.93	12.93
11—0	85	69.30	7.96	24	82.16	12.10	12.86	97	67.53	8.17	26	83.69	14.01	16.16
11—3	62	69.38	8.06	27	82.86	12.39	13.48	85	67.45	8.36	33	87.82	16.17	20.37
11—6	66	72.89	9.02	24	81.67	13.49	8.78	84	70.94	9.29	33	89.42	15.78	18.48
11—9	68	72.16	9.29	22	84.96	12.79	12.80	70	74.51	10.79	29	91.98	14.88	17.47
12—0	55	74.39	9.54	24	87.07	17.75	12.68	80	74.98	9.44	43	94.09	18.45	19.11
12—3	64	75.78	8.96	24	90.00	16.57	14.22	72	77.42	11.60	30	98.72	14.72	21.30
12—6	52	79.67	9.72	28	95.23	17.45	15.56	64	79.18	15.47	46	100.67	16.90	21.49
12—9	56	79.43	12.61	18	100.62	18.12	21.10	56	84.77	13.57	32	100.96	15.07	16.19
13—0	49	85.74	11.35	11	102.08	15.82	16.34	58	85.25	13.66	27	104.45	18.99	19.20
13—3	37	83.66	13.20	28	113.10	26.00	29.44	42	82.80	15.30	29	106.50	15.32	23.70
13—6	46	85.90	12.40	22	110.72	21.84	24.83	47	91.19	16.10	27	107.18	15.80	15.99
13—9	32	85.16	12.25	23	105.56	13.44	20.40	53	94.43	18.47	29	107.75	16.29	13.32
14—0	38	86.03	11.10	27	119.41	22.97	33.38	38	90.46	13.14	37	108.02	13.24	17.56
14—3	43	90.34	14.44	32	123.77	19.71	33.43	41	94.26	17.38	46	115.69	19.61	21.43
14—6	37	95.98	16.66	33	129.21	22.98	33.23	29	96.97	12.40	38	114.33	17.64	17.36
14—9	24	96.24	17.58	38	121.18	18.20	24.94	43	97.87	13.63	45	109.27	11.32	11.40
15—0	26	102.85	16.32	47	127.65	16.09	24.80	29	99.40	12.82	33	118.45	15.76	19.05
15—3	15	98.67	17.37	45	132.57	21.64	33.90	26	100.90	14.93	35	112.96	17.73	12.06
15—6	20	110.47	12.44	43	133.07	16.17	22.60	24	100.53	15.55	39	117.06	16.27	16.53
15—9	15	110.99	20.40	43	131.61	19.19	20.62	17	99.70	14.89	34	113.20	14.18	13.50

• *S.D.* = Standard Deviation.

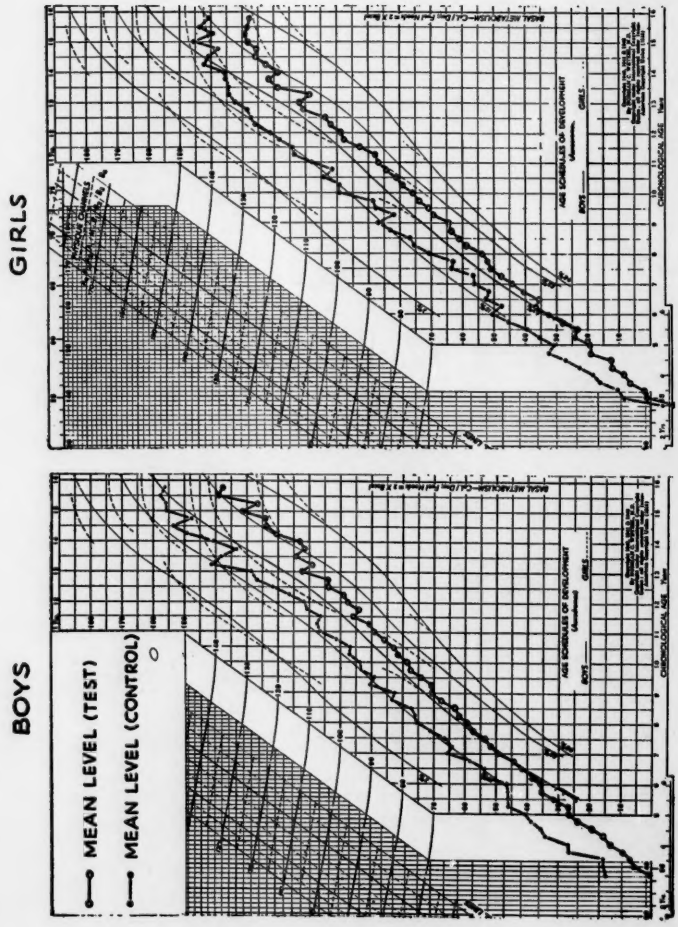

FIGURE 1—Comparison of mean isodevelopmental levels of test children with those of control children.

100.9 pounds at 15 years 6 months of age, a value reached by the control girls at 12 years 9 months.

The mean weight curves of the children in each group showed, in general, a progressive divergence throughout the age range included in this investigation. The mean weight curve of the control boys was more than plus one standard deviation removed from the mean weight values of the boys with nutritive failure at every age interval except 5 years 0 months. The mean weight curve for the control girls was more than plus one standard deviation greater than the mean weight values of the girls with the nutritive failure in the middle age range and either slightly above or below plus one standard deviation at the lower and higher ages. Conversely, the mean weight curve of the undernourished boys was more than minus one standard deviation removed from the means of the control boys in the upper age range and just above or below minus one standard deviation in the lower age range. In general, the mean weight curve of the girls with nutritive failure followed the course of the minus one standard deviation line calculated from the mean weight curve for the control girls.

Comparison of the Mean Speed of Growth of White Alabama Children With and Without Nutritive Failure

The mean isodevelopmental lines (Wetzel) reached by each group of children at each 3-month age interval are shown in Figure 1. The mean levels attained by the control children greatly exceeded those of the children with nutritive failure at each age. The mean differentials for the boys ranged from 8.70 levels at 3 years 6 months to 32.56 levels at 14 years 0 months; those for the girls ranged from 2.91 levels at 3 years to 26.11 levels at 13 years 3 months. The mean difference in levels at each age interval was 15.27 levels for the boys and 15.91 levels for the girls. The maximum mean developmental levels reached by the boys and girls with nutritive failure were 140 and 130 attained at ages 15 years 6 months and 15 years 3 months respectively. The control boys and control girls reached the corresponding identical mean developmental levels at 13 years 3 months and 12 years 9 months respectively.

The curves denoting the mean speed of growth for each sex in each group are shown in Figure 1. The mean pathway followed by the control boys ran between the 2 per cent and 15 per cent auxodrome from 3 years to 6 years, along the 15 per cent auxodrome from 6 years to 9 years 9 months and between the 15 per cent and 67 per cent auxodrome between 9 years 9 months and 15 years 9 months. The mean curve of the boys with nutritive failure paralleled that of the control boys until 13 years after which the curves diverged. The pathway followed by this curve started between the 15 per cent and 67 per cent auxodrome and drifted progressively to the right, crossing the 67 per cent auxodrome at 7 years 3 months and the 82 per cent auxodrome at 13 years 8 months. The mean pathway of the control

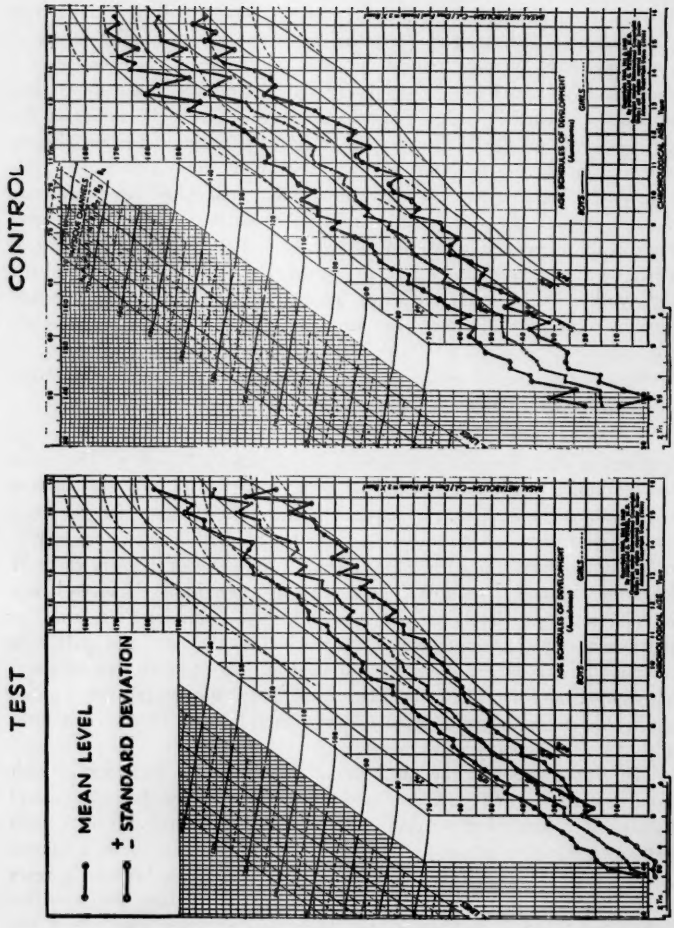

FIGURE 2—Mean isodevelopmental levels and standard deviations of test and control boys.

boys was greater than plus one standard deviation removed from the mean pathway of the boys with nutritive failure throughout the age range included in this study (Figure 2). In contrast, the mean pathway followed by the boys with nutritive failure was either equal to or slightly below the minus one standard deviation line derived from the mean curve of the boys in the control group.

The mean auxodrome followed by the control girls vacillated along the 15 per cent line or between the 15 per cent and 67 per cent lines from 3 years to 11 years 3 months, after which it drifted to the right and ran out its course along the 67 per cent auxodrome line. The mean of the girls with nutritive failure followed a course considerably slower than that of the girls in the control group. The two curves showed a slight but progressive divergence throughout the age range of the study. Starting to the left of the 67 per cent line, the mean curve for the undernourished girls crossed the 67 per cent line at 6 years, crossed the 82 per cent line at 11 years, and ran out its course between the 82 per cent and 98 per cent lines. The mean pathway followed by the control girls exceeded that of the undernourished girls throughout the middle age range by more than plus one standard deviation and was just above or just below the plus one standard deviation line in the upper and lower age ranges (Figure 3). In contrast, the pathway taken by the mean curve for the girls with nutritive failure vacillated throughout its entire course about the minus one standard deviation line developed from the mean curve for the control girls.

Discussion

The degree to which chronic nutritive failure affects the growth progress of a child is determined by the interplay of genetic and environmental influences. Although these influences are highly specific, the use of ethnically identical groups of children from the same geographical area permits the derivation of certain general relationships between the growth progress of normal children and children with chronic nutritive failure. Thus, a comparison of the mean heights and weights of two such groups of children between 3 years of age and 15 years 9 months of age showed that the greatest amount of growth lag in boys with chronic nutritive failure occurs prior to 3 years of age, during the post-pubescent period and during the early adolescent period. Girls with chronic nutritive failure undergo a progressive lag in weight which begins prior to 3 years of age and continues through early adolescence, while the height lag present at 3 years of age remains relatively constant throughout the same period.

As measured by the Wetzel Grid, the mean speed of growth of the control children who served as the reference group was considerably greater than the Wetzel "normal" during the period of childhood, and substantially greater than the mean speed of growth of the children with nutritive failure

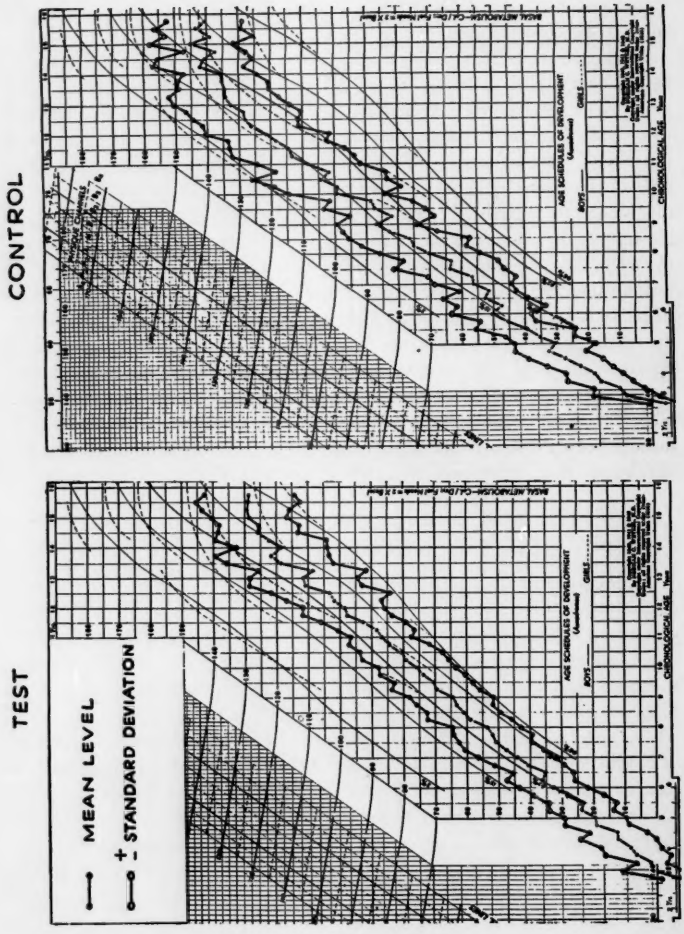

FIGURE 3—Mean isodevelopmental levels and standard deviations of test and control girls.

in the entire age range included in this investigation. The mean curves denoting the speed of growth of the reference group and of the group with nutritive failure were characterized by a drift to the right, a change indicative of a slowing in the speed of growth with increasing age. This drift was much more pronounced in the group with nutritive failure than in the reference group.

The height, weight and speed of growth values of the individual children in both groups showed considerable overlapping, a finding which decreased in prevalence at the higher ages. Overlapping in height and in speed of growth occurred more frequently than in weight, despite the lesser dispersion of height values about the means as compared to weight values. This observation, together with the large differences between the mean weight curves of the groups with and without nutritive failure suggest that the same degree of undernutrition exerts a greater retarding influence on weight progress than on height progress. Because of the overlapping noted between the individual values in the two groups of children, however, the superficial and more obvious manifestations of growth failure resulting from chronic undernutrition often may be obscured by the intensity of the inherent growth-promoting factors operating within a child.

Summary and Conclusions

A total of 8774 examinations were made on 2965 children ranging in age from 2 years 11 months to 15 years 11 months in the decade between 1942 and 1952. (These children were not included in the supplementation program of the Nutrition Clinic.) Five hundred and sixty-one children had clinical evidence of nutritive failure. By comparing the height and weight values of these children with those of the 2404 ethnically identical children without nutritive failure, it was found that:

1. In boys and girls with nutritive failure a substantial lag in height and in body weight is present by the third year of age. Thereafter, the weight lag increases progressively in both boys and girls with nutritive failure.

2. The height lag in the boys with nutritive failure becomes progressively greater after three years of age whereas that in girls remains fairly constant.

3. The mean speed of growth as determined by the Wetzel Grid is greater in the children without nutritive failure than in the group with nutritive failure.

4. The mean speed of growth declines in both groups as their ages increase. When plotted on the Wetzel Grid there is a progressive drift to the right in the mean curves on the auxodrome panel from 3 to 16 years of age.

As striking as were the differences between the mean height, weight and speed of growth values between the groups with and without nutritive failure, individual children showed overlapping at each age. The mean

curves for height, weight and speed of growth in the group without nutritive failure approximated the corresponding plus one standard deviation lines of the group with nutritive failure. Conversely, the mean curves of the group with nutritive failure approximated the minus one standard deviation lines of the group without nutritive failure.

These studies show that while failure to reach the average height, weight or speed of growth for a particular sex at a particular age is suggestive of poor quality growth due to faulty nutrition, corroborative clinical evidence is essential in the final evaluation of the nutritional status of the child.

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COMPARISON OF GROWTH IN HEIGHT AND WEIGHT BETWEEN ECTOMORPHIC AND MESOMORPHIC BOYS [1]

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Most of the early published growth studies were primarily concerned with the establishment of standards for height and weight for the average child within a given ethnic group or socio-economic level (1, 3, 5). More recently the emphasis has shifted to a consideration of the individual child and the problem of the interpretation of growth status in terms of the child's own pattern of development (6). Concurrently, the need for studies of growth patterns in children of different body types has been realized in many quarters. With the introduction by Sheldon (4) of a method for classifying physique by somatotype components, research in child growth has been provided with a powerful new tool for describing physical differences. The present investigation has made use of the somatotyping technique for selecting subjects for a study comparing the visible physical growth of two groups of young men of contrasting physical build. Chosen for study were a group of predominant ectomorphs characterized by linearity and delicacy of body structure and a group of predominant mesomorphs with pronounced muscular development and ruggedness of structure. The purpose of the investigation was to determine whether the records of height and weight for the two groups indicated the same contrast in physical build throughout the growth period as was observed at the young adult state.

The Data

All subjects for this study were formerly enrolled in the Brush Foundation series. The Brush Foundation under the direction of T. Wingate Todd collected developmental data on a large series of Cleveland children from an economically and socially homogeneous population during the years 1928 to 1942. A majority of these same children have also been subjects in the dento-facial growth study directed by Dr. Holly Broadbent of the Bolton Fund Study. In 1951 a group of 125 boys from this series, now young adults, were photographed for a somatotype study. From the somatotypes two groups with contrasting physical characteristics were selected for a comparative study of height and weight during the growth period

[1] We are indebted to Dr. Holly Broadbent for permission to use certain height and weight data collected in the Bolton Study and to Dr. Idell Pyle for helpful suggestions and criticism.

from 2 to 17 years of age. The members of one group were predominantly mesomorphic each with a rating of five or higher in the second component of the somatotype, the other series was composed of ectomorphs, each member of which had been given a rating of five or more in the third component. To insure as great a contrast in physical type as possible between the two series, the mesomorphs were restricted only to those who showed a

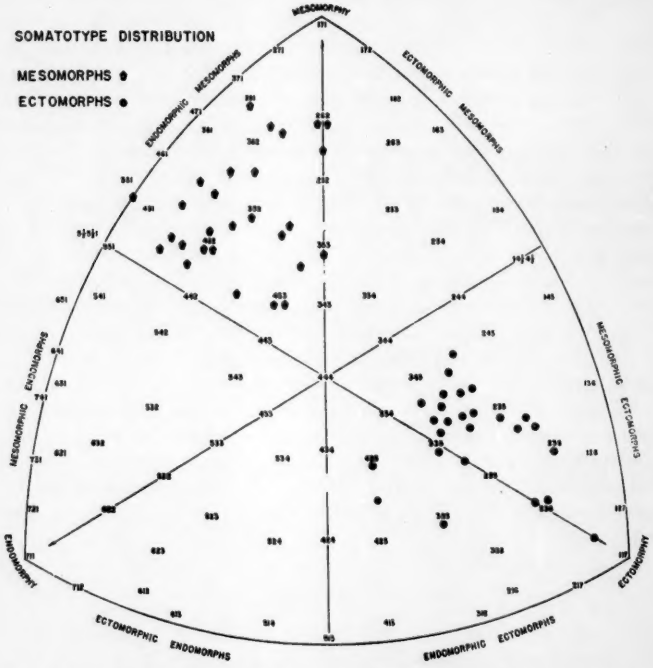

FIGURE 1—Somatotype distribution of the 26 ectomorphs and 28 mesomorphs used as subjects in this study.

rating of three or less in the third component and except for three cases the ectomorphs all showed a rating of three or below in the second component. Of the three exceptions among the ectomorphs two were rated a four in mesomorphy and one was classified as a three and one-half in this component. Figure 1 shows the somatotype distribution for the two compared groups. The records of height and weight taken during childhood were obtained from the files of the Brush Foundation Study and the Bolton Study. There was no evidence from the histories that any of these boys

had had any serious illness which would have permanently altered physical growth. Furthermore, each subject was in a normal state of health when somatotyped.

Measurements of height and weight were made during childhood at yearly intervals within a week of the birthday. Height was measured by an anthropometer of the Martin design with the child standing on the floor erect as possible, the shoes removed. For the statistics in this analysis the height measurements have been converted from millimeters to inches and tenths of inches. Weight was registered in pounds on a Fairbanks scale after removal of shoes but not of clothes.

The mesomorphs are represented by 28 subjects and the ectomorphs by 26. Unfortunately, only a few members of each series were followed throughout the full 17 years in the Brush and Bolton studies and in some instances there are gaps of one or two years in the records. For these reasons the number of subjects at the different age levels varies considerably and in many cases is far less than the total number in each series.

Results

The mean somatotype component values for the series of ectomorphs ($N = 26$) and mesomorphs ($N = 28$) as revealed at the time they were photographed are as follows:

	Component I (Endomorphy)	*Component II* (Mesomorphy)	*Component III* (Ectomorphy)
Ectomorphs	2.65	3.04	5.21
Mesomorphs	3.46	5.36	2.02

The mean age, height, nude weight and height over cube root of weight ratio for each series at the time the somatotype photographs were taken are as follows:

	Age (Years)	*Stature* (Inches)	*Weight* (Pounds)	*Height / Cube Root of Weight*
Ectomorphs	20.8	71.4	142.0	13.73
Mesomorphs ...	21.6	69.1	168.7	12.53

Both groups averaged about the same age at that time, 21 years, with an age range from 16 to 30 years for each series. At the mean age of 21 years the ectomorphs averaged 2.3 inches taller and 26.7 pounds lighter in weight than the mesomorphs. This contrast in body size and bulk is reflected in the great difference in the mean values for the height over cube root of of weight index. Such a difference is to be expected since the ectomorphs

were selected because of their linearity and delicacy of structure whereas the mesomorphs were chosen because of their pronounced muscular development and ruggedness of structure.

The results of the comparisons of the height and weight data for the two series are shown in the following series of graphs. In these graphs the arrow symbol indicates that the differences of means at the specified age is statistically significant.

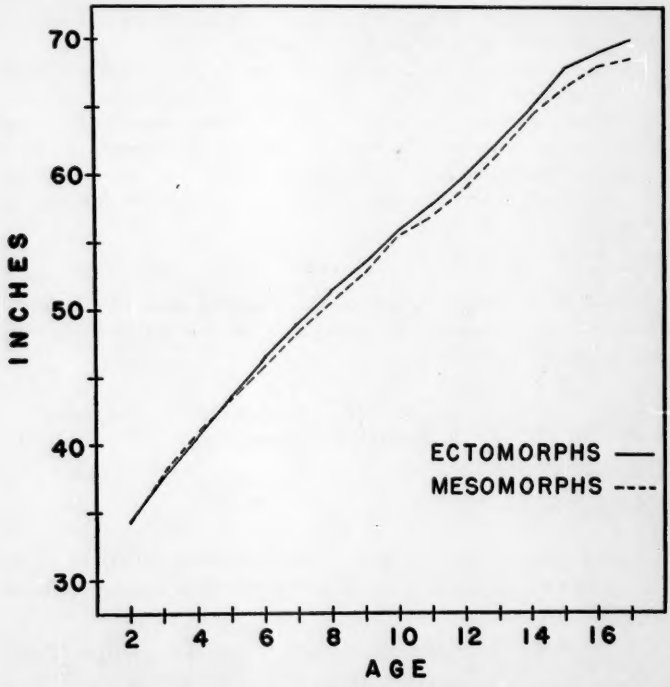

FIGURE 2—Growth curves in average stature for the ectomorphs and mesomorphs from 2 to 17 years of age.

Figure 2 shows the growth in height of the two groups of boys. It will be seen that from ages 2 to 4 years the mesomorphs average slightly taller than the ectomorphs but that from age 5 through 17 the reverse is true. Although the ectomorphs average about one-half inch taller than the mesomorphs at ages 6 to 10 years and as much as one and three-quarters inches taller at age 17 years, the differences of means between the two groups does not attain the level of statistical significance at any age period.

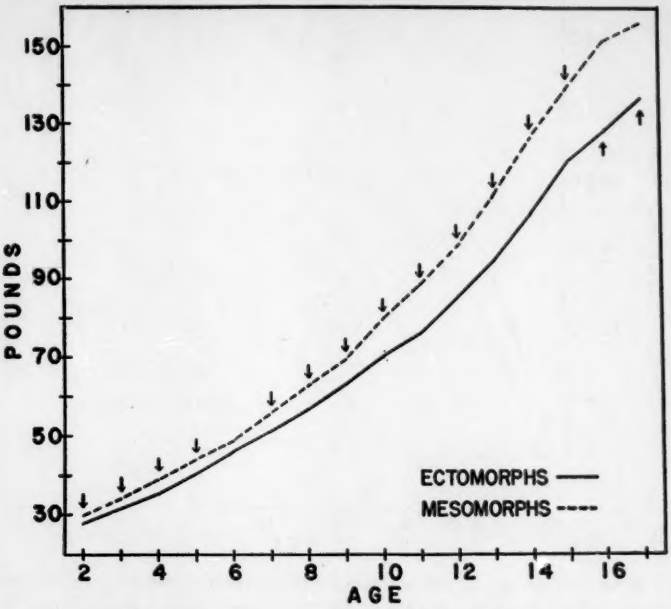

FIGURE 3—Growth curves in average weight for the ectomorphs and mesomorphs from 2 to 17 years of age.

A consideration of Figure 3 which shows the weight curves for the two compared series, reveals that the mesomorphs are heavier than the ectomorphs at every age from 2 through 17 years. The difference of means is statistically significant at each age level, except at age 6 years. There is a fairly steady increase of weight superiority in the mesomorphs from about two pounds at age 2 to between 16 and 23 pounds in the age span from 13 to 17 years. The mean weight difference at age 21, as noted above, was almost 27 pounds.

The curves for the height over cube root of weight ratios are shown in Figure 4. Since the ectomorphs average somewhat taller and considerably lighter in weight throughout most of the growth span it is not surprising that the mean height-weight ratios of the ectomorphs should be significantly higher than those of mesomorphs throughout this entire period.

There is a steady elevation in the mean height-weight index for both groups from age 2 to about the beginning of adolescence. Among the ectomorphs there is a leveling off in the mean index through the age span 11

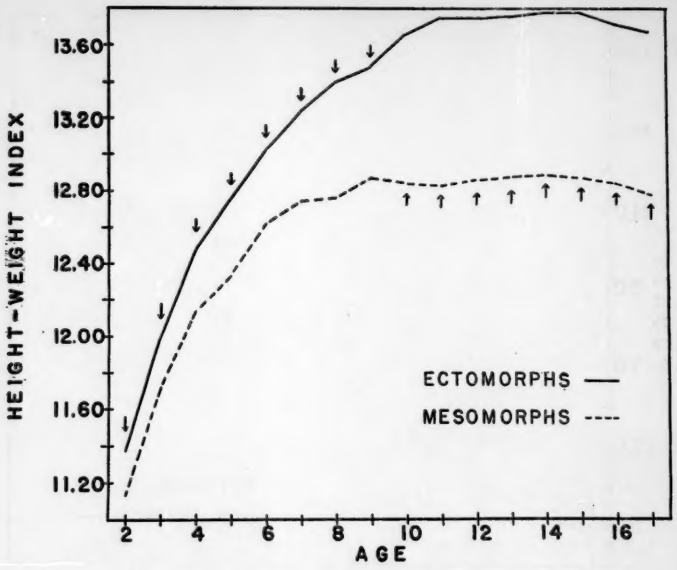

FIGURE 4—Average height over cube root of weight index at the various age levels from 2 to 17 years for the ectomorphs and mesomorphs.

to 15 years with a slight drop thereafter. The same phenomenon occurs in the mesomorphic series but the leveling off process begins two years earlier at age 9 years. In the case of the ectomorphs it appears that the relationship between height and weight remains quite constant from age 11, throughout the teens and possibly on into the third decade of life. As shown previously, the mean index for the ectomorphs at average age 21 years was 13.73. Among the mesomorphs the plateauing of this mean index covers only the years 9 to 15 indicating a fairly constant ratio between height and weight for this period, but the drop in the index after age 15 suggests that these boys are adding weight more rapidly in the late teens. Their mean height-weight ratio falls to 12.63 at average age 21 years.

The curves for the average annual increments in height for the two series of boys are given in Figure 5. In both groups the mean yearly increment in stature decreases rather steadily from age 2-3 years to age 10-11 years, although almost every year during this period the ectomorphs increase their stature slightly more than do the mesomorphs. From ages 10 to 14 years the picture is reversed and for this period the mesomorphs show a greater yearly increase in height. The puberal growth spurt appears to start at

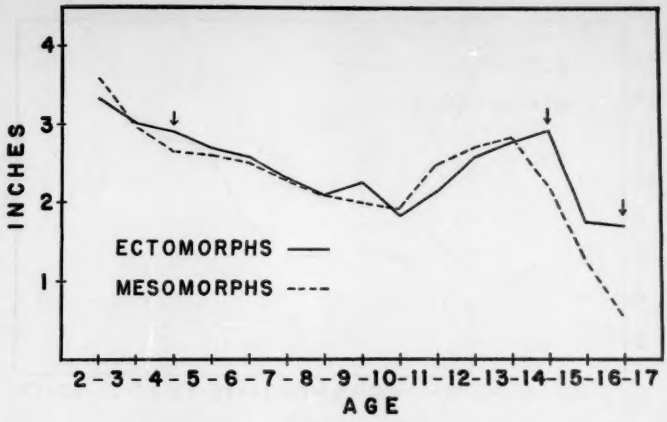

FIGURE 5—Mean annual increments of stature for the ectomorphs and mesomorphs for ages 2-3 years through 16-17 years.

about the same time (age 10 to 11 years) in both groups but the greatest mean yearly increment in height occurs during the year 13 to 14 among the mesomorphs and at age 14-15 for the ectomorphs. After reaching their respective peaks, both groups fall off sharply although the mean yearly increase in stature remains at a higher level for a longer period of time among the ectomorphs than among the mesomorphs. The inference to be drawn from this is that the ectomorphs continue to grow over a greater length of time than do the mesomorphs.

Although the trends in the mean yearly increments in stature present a different picture for the two groups, for the most part the differences of means at corresponding age levels are not statistically significant. They reach the level of significance only at ages 4-5, 14-15, and 16-17 years.

The curves showing the mean yearly increases in weight for both series are presented in Figure 6. Here it is seen that the year to year increment in weight is consistently higher for the mesomorphs than for the ectomorphs.. The difference of means attains statistical significance for ages 6-7, 9-10, 10-11, and 11-12 and approaches significance at 13-14 years. For the mesomorphs the mean increase in weight gets larger each successive year (except for age 5 to 6) until a maximum is reached at age 13-14 years. For the ectomorphs there is a fairly steady rise in the mean value until age 8-9 years and then for a two year period the mean weight increase falls off slightly. It picks up again from ages 10-11 and 11-12 years with the sharpest rise between 11-12 and 12-13 years. The peak increase occurs at age 14-15 years for this group. The mean increase falls off rapidly in both

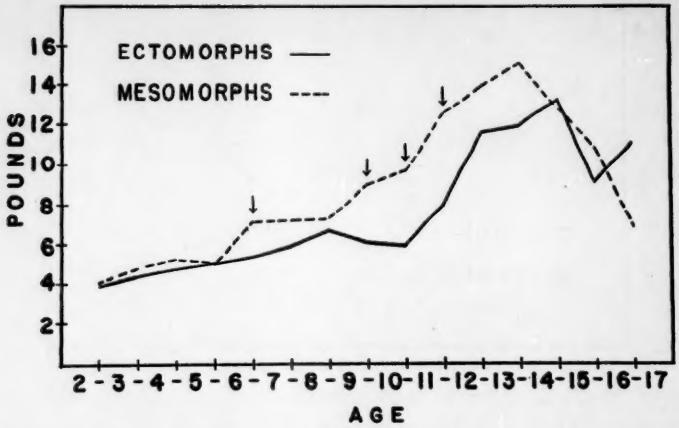

FIGURE 6—Mean annual increments of weight for the ectomorphs and mesomorphs for ages 2-3 years through 16-17 years.

groups after their respective peak periods although the value rises again among the ectomorphs between 15-16 and 16-17 years.

A further method for comparing growth status in the two series is shown in Figure 7. Here are plotted the mean percentages of adult stature attained at each age for both the ectomorph and the mesomorph series. For these calculations the level of adult stature was taken as of age 18 years or above. The few subjects who had not yet reached their eighteenth birthday at the time they were somatotyped are not included in this part of the study.

The results here show that at every age the mesomorphs collectively have attained a higher percentage of their ultimate adult stature as compared to the ectomorphs. Furthermore, the difference of means surpasses the 4 per cent level of statistical significance at every age from 3 through 15 years. It would appear, then, that although the ectomorphs actually average taller than the mesomorphs at almost every age level, they consistently lag behind them in growth achieved relative to final adult stature throughout the entire growth period considered in this study.

DISCUSSION

The results of this study appear to suggest that at least for ectomorphs and mesomorphs the somatotype remains relatively constant throughout childhood. A comparison of the growth data indicates that there are differences in body build between the ectomorphs and mesomorphs during childhood which are consistent with their somatotype classifications as young

adults. Our ectomorphic young men were taller and both absolutely and relatively lighter in weight than our mesomorphic young men and these same differences in height and weight were found to be present at practically every age level during the growth span. These findings are perhaps not surprising in the light of what is already known from studies by Wetzel (7, 8) and others. Children in general appear to follow developmental pathways which are in large measure determined by their genetic

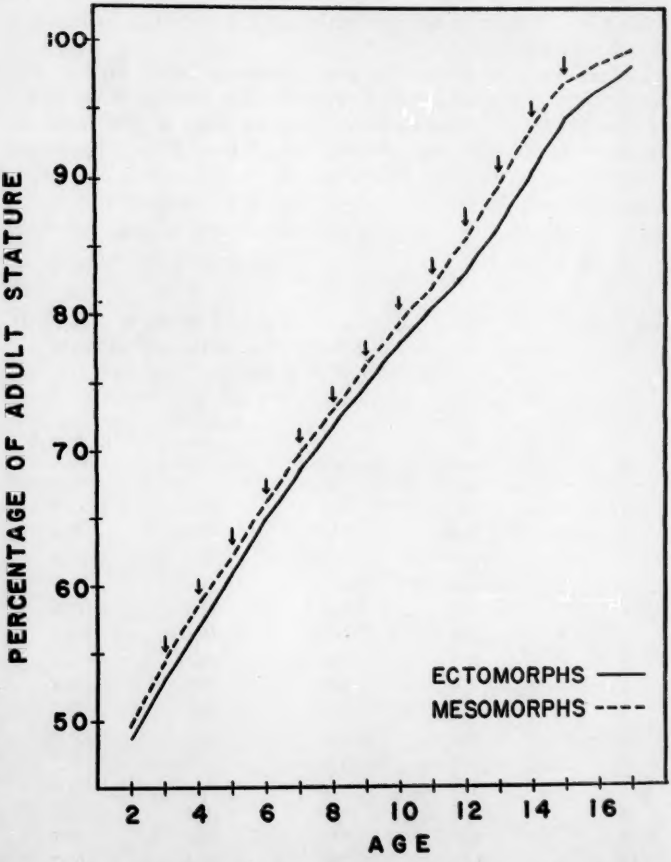

FIGURE 7—Mean percentage of adult stature attained by the ectomorphs and mesomorphs at various age levels from 2 to 17 years.

endowments. Apparently rugged, powerfully built mesomorphic children seldom end up as ectomorphic adults, nor do ectomorphic children, in the normal course of events, suddenly or even gradually change into heavy boned, muscular mesomorphic adults.

The results of this study show that throughout the growth period the greatest differences between the two groups occur in weight rather than in stature. Increase in height frequently is the accepted yardstick against which to assess relative growth status. Linear growth, however, is only one manifestation of the maturing organism; increase in size and bulk of the differential structures of the body are equally important as indicators of growth achieved.

Unanticipated, but perhaps the most interesting finding in this study, are the differences in the growth patterns observed between the two groups of boys. The shorter, heavier mesomorphs were found to grow faster and to mature earlier. The peak of their puberal spurt in both height and weight occurs on the average about one year earlier than it does among the ectomorphs. The overall growth period for the ectomorphs appears to cover a longer span of years whereas the attainment of adult stature for

TABLE 1

COMPARISON OF MEAN PERCENTAGES OF ADULT STATURE ATTAINED AT THE DIFFERENT AGES FOR THE ECTOMORPHS, MESOMORPHS, AND DR. BAYLEY'S SERIES

Age	*Ectomorphs*	*Mesomorphs*	*Combined Ectomorphs and Mesomorphs*	*Dr. Bayley's Series*
2	48.7	49.5	49.2	48.5
3	53.0	54.4	53.7	53.0
4	56.8	58.6	57.7	57.6
5	65.0	62.4	61.6	61.7
6	61.0	66.2	65.5	65.5
7	68.6	69.8	69.2	69.3
8	71.9	73.0	72.4	72.0
9	74.9	76.2	75.5	75.0
10	77.9	79.5	78.8	78.1
11	80.6	82.1	81.4	81.0
12	83.2	85.6	84.4	83.8
13	86.6	89.6	88.2	87.3
14	90.4	93.9	92.4	91.5
15	94.5	97.2	95.8	95.5
16	96.4	98.4	97.6	97.7
17	98.2	99.3	98.8	98.8

the mesomorphs is achieved in a shorter length of time, and the process of growth seems to be more intensified particularly during adolescence. Growth in height ends sooner for the mesomorphs and the accompanying increase in body bulk (weight) begins earlier for them.

From the evidence presented here it appears that ectomorphic children grow more slowly than do mesomorphic children, at least in terms of growth achieved at any particular age relative to ultimate adult stature. In this respect, it is of interest to compare the mean values of percentage of adult stature attained at each age level for these two series with the figures published by Bayley (2) for a much larger series of boys presumably comprising a wide range of somatotypes (Table 1). Here we find that the mean percentages for the ectomorphs are consistently lower than those of Dr. Bayley's study and similarly the mean values for the mesomorphs are uniformly higher than the ones she cites. If we pool the figures for our two series, however, we find that the results more nearly agree with hers at almost every age level.

Summary and Conclusions

1. From a somatotype study of 125 young men, 26 ectomorphs and 28 mesomorphs were selected for a comparative study of their physical growth as indicated by measures of height and weight from 2 to 17 years of age. At the time they were somatotyped both groups averaged about 21 years of age and the ectomorphs averaged 2.3 inches taller and 26.7 pounds lighter in weight than the mesomorphs.

2. The results of the study showed that from 4 to 17 years of age the ectomorphs averaged consistently taller than the mesomorphs. The mesomorphs, however, averaged significantly heavier both absolutely and relatively than the ectomorphs at each age from 2 to 17 years.

3. A comparison of the growth curves showed that the mesomorphs reached their peak in puberal spurt in both height and weight on the average about one year earlier than the ectomorphs.

4. The ectomorphs were found to grow in height over a longer period of time than the mesomorphs.

5. The mesomorphs appeared to grow faster in that they consistently attained a higher percentage of adult stature at each age level as compared to the ectomorphs.

6. The conclusions are that the somatotype as indicated by measures of height and weight remains fairly constant, at least for ectomorphs and mesomorphs, throughout childhood and well on into the young adult period. Since growth patterns for boys of contrasting body build are shown to be different, this finding indicates the desirability of further study of growth

patterns in childhood of different body types to open the way for more comprehensive research into the problems of individual growth and development.

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THE SEX DIFFERENCE IN THE BASAL METABOLIC RATE

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The existence of a sex difference in the basal oxygen consumption is a matter of considerable importance, both of itself and in its broader implications. Since boys have a higher oxygen consumption under basal conditions, beginning even before the eighth year (6, 7), separate norms for boys and girls obviously are necessary. The fact that the basal metabolic rate of the adult male appears to be so much higher than in the female bears upon sex differences in behavior, and in mortality and morbidity as well. Pearl, among others, has attributed the shorter life span of the male to his higher level of energy metabolism, or as Pearl termed it to his "faster rate of living."

But before accepting a causal relationship between the higher metabolism and the shortened life span of the male, it is well to be sure that the male does have a higher metabolic rate, after due corrections for body size and body composition. It is noteworthy that the large sex difference in oxygen consumption, observable by the early teens, lessens when correction is made for differences in body size, or in the extent of body surface. Even so, there is a residual difference in oxygen consumption which increases after the first decade, but stabilizes before the time of legal majority (6).

This residual difference is of especial interest since it parallels changes in body composition. Briefly stated, boys and girls are reasonably comparable in the proportions of fat and muscle until about the 11th year (10). Thereafter boys increase markedly in the proportion of muscle, while girls add a higher proportion of fat (9, 10). In the adult state this difference continues to be true (1, 12) and may even become quite exaggerated (5).

Now, the lean body mass, or more particularly the amount of skeletal muscle, appears to be the single largest determinant of the basal oxygen consumption (4, 8), with correlations between the two variables from 0.8 to 0.9. Thus, males and females or boys and girls of equivalent body weight may still differ considerably in the amount of muscle present, and therefore in basal oxygen consumption. Under these circumstances older boys and adult males could have a higher oxygen consumption per unit of mass simply because of their greater muscle content.

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To investigate this possibility we have assembled data on metabolism, body size, and muscle mass for boys and girls between the 6th and the 18th year of life. It is the purpose of this study to ascertain whether the sex difference in the basal metabolic rate is attributable to sexual dimorphism in size and internal composition.

Methods and Materials

Basal metabolic determinations were made on 76 boys and 69 girls, all participants in the Fels Longitudinal Studies, under morning-fasting conditions using the Jones-Basal, a bellows-type oxygen-circulating machine. From the average of two runs, other than the trial run, the time required to consume one liter of oxygen was computed in each case. This value, in turn, was converted into calories per 24 hours as is commonly done.

In addition to the data on oxygen consumption, the following values were also recorded at the time of testing. Age (in years and months), stature (in centimeters), and weight with light underclothing (in kilograms). From these values the proportion *calories per kilogram* was computed for each averaged test result. Oxygen consumptions were not calculated as a percentage of expected values as done in clinical studies, since the actual values were needed throughout.

Measurements of leg musculature were obtained from lateral-leg roentgenograms, taken at a standard distance of 6 feet, as described by Reynolds (10). In each case, the maximum diameter of the muscle shadow was recorded as measured with a vernier micrometer (Fisher No. 12-130) following the technique described by Garn, Clark and Portray (4). No corrections were made for magnification, constant and under 3 per cent, and bone size was not subtracted out.

Using the available leg muscle measurements, a matched pair series was made up, matching boys and girls as closely as possible. In no case did the members of a pair differ by more than 2 mm. in leg muscle diameter, and the mean difference for the 27 pairs so matched was 0.05 mm., or less than 1 per cent of the average leg muscle diameter.

In making the calculations, two-year age groupings were used, and the means for each of 12 age-sex groups were calculated separately. Two of the graphic representations (Figures 2 and 3) employed logarithmic plots as described by Croxton and Cowden (3). Such plots were used both to simplify the illustrative process and to straighten trend lines where needed.

It was not the purpose of this study to present normative data, which has been done most adequately by the Carnegie group and more recently by Lewis and his associates (6, 7). However, the data may be considered representative of healthy native-born white children from Southwestern Ohio, and correspond closely to published data on similar groups.

Findings

The sex difference in the basal metabolic rate was investigated first against the background of age changes. To do this, data on basal oxygen consumption were sorted by sex and age groups, as previously described. The mean values for the age groups thus showed the extent of age changes and the magnitude of sex differences.

Table 1

OXYGEN CONSUMPTION, OXYGEN CONSUMPTION PER KILOGRAM, WEIGHT AND HEIGHT BY AGE AND SEX

Sex	*Age*	*N*	Height (cm) *Mean±S.D.*	Weight (kg) *Mean±S.D.*	O_2 per 24 Hrs *Mean±S.E.*	O_2 per Kg *Mean±S.E.*
Boys ..	6– 7 ..	42	124.4±4.8	24.3±3.3	1145±17.1	47.3±0.7
Girls ..	6– 7 ..	27	125.3±7.3	27.9±3.9	1095±19.4	46.6±0.9
Boys ..	8– 9 ..	39	136.0±4.5	30.8±4.4	1252±19.8	41.0±0.5
Girls ..	8– 9 ..	36	135.4±5.2	28.8±4.7	1167±19.6*	41.1±0.7
Boys ..	10–11 ..	29	145.2±5.3	36.6±6.1	1322±23.8	36.7±0.9
Girls ..	10–11 ..	36	145.7±6.8	35.8±6.3	1268±26.2	35.9±9.6
Boys ..	12–13 ..	33	155.7±9.5	47.6±9.6	1546±35.6	33.5±0.8
Girls ..	12–13 ..	40	156.4±7.5	44.3±6.8	1354±26.6*	30.7±0.6*
Boys ..	14–15 ..	33	170.0±7.5	60.8±9.9	1779±36.2	29.7±0.7
Girls ..	14–15 ..	38	160.2±7.7	52.4±7.9	1375±18.2*	26.8±0.6*
Boys ..	16–18 ..	28	177.8±4.8	70.6±7.5	1841±42.1	26.3±0.3
Girls ..	16–18 ..	28	162.9±6.6	54.7±8.1	1321±23.1*	24.7±0.7*

*Sex difference in oxygen consumption significant at $p = .05$ or better.

As shown in Table 1, and illustrated in Figure 1, basal oxygen consumption was at all age levels higher in the boys, though in the younger age groups the sex difference was not large. Beginning with an average of 1,145 calories per 24 hours in the age group 6-7, oxygen consumption in the boys rose to 1,841 calories per 24 hours in boys 16 and over. In contrast, in the same age range oxygen consumption rose from 1,095 calories per 24 hours in the youngest group to over 1,300 calories in the older girls. The nine-year increase in the boys (696 calories per 24 hours) represented a gain of 60 per cent. In the girls the increase amounted to 300 calories, half as much as in the boys, and slightly over 30 per cent on a percentage basis. Though both sexes exhibited an age-associated increase in basal oxygen consumption, the age increment was markedly greater in the boys.

Since the age-associated increases in oxygen consumption were at least in part due to increases in body size, admittedly greater in the boys, it was necessary to correct for age and sex differences in mass. To do this, all data

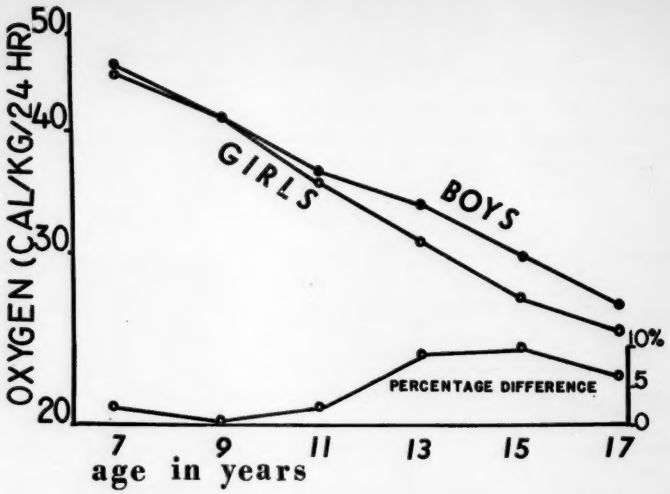

FIGURE 1—Age changes in basal oxygen consumption. Note the consistently higher oxygen consumption of the boys, and the disproportionate increase beginning early in the second decade.

were recomputed on a uniform basis as calories per kilogram of body weight. When this was done (Table 1) and plotted (as in Figure 2), the extent of sex differences in oxygen consumption was somewhat minimized. Both boys and girls exhibited the characteristic *decrease* in oxygen consumption per kilogram of body weight with increasing age and size. Nevertheless, oxygen consumption per kilogram of body weight continued higher in the boys at all age levels, and the rate of decrease was less in the boys aged 10 and over. Thus in the later years the sex difference in oxygen consumption per kilogram of body weight was as much as 3 calories per kilogram, or 10 per cent. Evidently the larger body mass, characteristic of the older boy, does not entirely account for the observed sex difference in basal oxygen consumption.

But since sexual dimorphism involves a difference in body composition as well as the greater body mass of the male, it was important to determine whether adequate correction for this sex difference would account for the difference in oxygen consumption. Accordingly the matched pair series was set up, wherein boys and girls were carefully matched in leg muscle diameter. In this way, comparability was assured for the amount of skeletal muscle, an important determinant of metabolic activity. However, though the 27 pairs of boys and girls were carefully matched in terms of

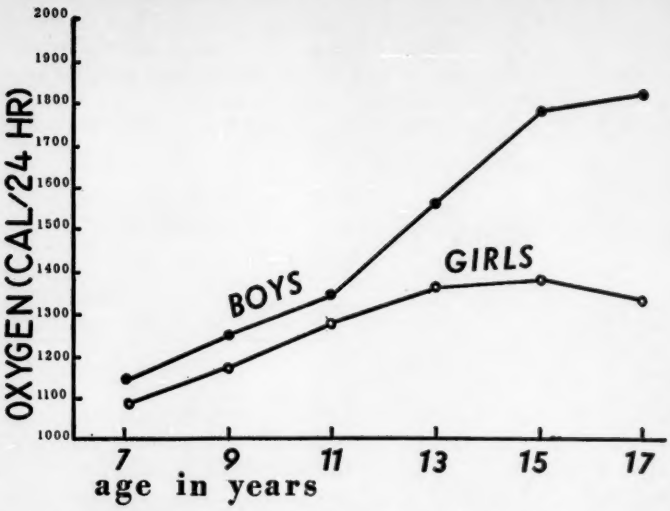

FIGURE 2—Age changes in oxygen consumed per kilogram of body weight. Teen-age boys and girls differ by as much as 10 per cent, indicating a higher level of oxygen consumption per unit of mass for the boys.

muscle size (Table 2) with a mean difference of less than 1 per cent, the sex difference in basal oxygen consumption was not eliminated. As shown in Figure 3, 66 per cent of the boys had a higher basal oxygen consumption than girls of comparable muscle mass. This was true also when computed on a per-kilogram basis. Pubertally and postpubertally *all* of the boys had a higher oxygen consumption under basal conditions than did girls paired with them on the basis of muscle size. Thus, while differences in muscle mass do have a marked effect on oxygen consumption, it cannot be said that such differences entirely account for the higher metabolic activity of the male. Boys and girls of equivalent muscle mass differ nearly as much in metabolic activity as boys and girls of equivalent body weight.

DISCUSSION

The findings in this study, as in others (6, 7), demonstrate the extent and the pattern of the sex difference in basal oxygen consumption. During childhood boys and girls are not markedly different in their average oxygen requirements in the basal (morning-fasting) state; still, oxygen consumption is consistently higher in the boys. However, well before the appearance of pigmented pubic hair, areolar changes, or alterations in the

sebaceous activity of the skin, the sex difference in basal oxygen consumption increases. Even during the age span when girls exceed boys in stature, the boys have higher metabolic requirements. Though absolute oxygen consumption increases until at least the 16th year in both sexes, the rate of increase as well as the volume consumed is greater in the boys. Whereas the mean oxygen consumption for boys is scarcely 4 per cent above that

TABLE 2

OXYGEN CONSUMPTION OF BOYS AND GIRLS PAIRED ON THE BASIS OF MUSCLE SIZE

Pair No.	Leg Muscle (mm)			Calories per 24 Hrs			Calories per Kg		
	Boy	*Girl*	*Diff*	*Boy*	*Girl*	*Diff*	*Boy*	*Girl*	*Diff*
1	73.3	74.7	—1.4	1210	1090	120	38.9	42.9	—4.0
2	74.8	74.8	0.0	1070	1246	—176	48.1	41.6	6.5
3	76.8	76.8	0.0	1059	1110	— 51	42.3	44.5	—2.2
4	75.8	77.1	—1.3	1317	1357	— 40	55.8	28.2	27.6
5	78.8	77.5	1.3	1294	1222	72	43.0	48.5	—5.5
6	78.1	79.1	—1.0	1374	1183	191	48.6	46.6	2.0
7	77.9	79.2	—1.3	1146	1340	—194	41.6	49.2	—7.6
8	82.1	80.4	1.7	1040	1236	—196	41.5	45.6	—4.1
9	78.9	80.9	—2.0	1275	1266	9	46.6	37.5	9.1
10	80.8	80.9	—0.1	1426	1360	66	41.1	40.5	0.6
11	82.3	82.2	0.1	1250	1114	136	49.2	43.1	6.1
12	84.5	84.5	0.0	1350	1390	— 40	40.7	41.4	—0.7
13	85.9	84.6	1.3	1340	1235	105	40.1	28.2	11.9
14	85.6	86.1	—0.5	1210	1310	—100	32.0	33.2	—1.2
15	88.2	88.2	0.0	1266	1226	40	34.1	34.4	—0.3
16	87.2	88.3	—1.1	1430	1236	194	40.1	24.4	15.7
17	90.7	88.7	2.0	1363	1159	204	42.6	23.2	19.4
18	90.4	91.2	—0.8	1250	1408	—158	38.1	34.9	3.2
19	90.9	91.5	—0.6	1342	1326	16	32.9	29.4	3.5
20	94.1	94.1	0.0	1326	1158	168	37.9	24.0	13.9
21	96.3	97.2	—0.9	1638	1280	358	34.4	27.9	6.5
22	97.9	97.7	0.2	1661	1466	195	24.0	28.1	—4.1
23	101.6	100.4	1.2	1484	1278	206	36.5	27.6	8.9
24	102.9	101.3	1.6	1732	1230	502	31.0	23.6	7.4
25	102.2	101.5	0.7	1357	1466	—109	34.5	25.5	9.0
26	106.7	105.2	1.5	1661	1427	234	28.7	24.6	4.1
27	114.3	113.5	0.8	1950	1693	257	27.9	25.4	2.5
Average	88.1	88.1	0.05	1364	1289	74.4*	39.0	34.2	4.2*

* Difference significant at $p = .001$ or better.

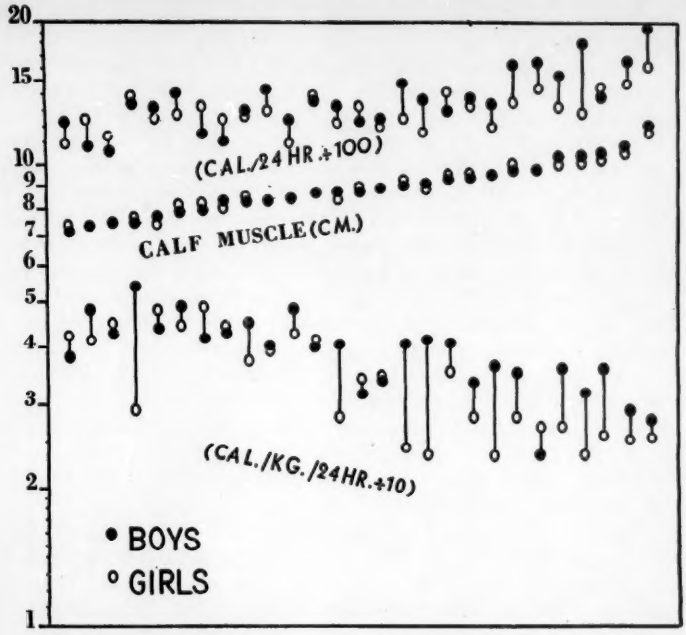

FIGURE 3—Metabolic data for 27 pairs of boys and girls matched on the basis of leg muscle diameter. Despite the closeness of the muscle matches, the boys still consume more oxygen and more oxygen per kilogram of body weight.

of girls during childhood, in the late teens the basal metabolic rate of boys is 30 per cent greater than that of girls. The necessity for different metabolic standards is thus evident.

But absolute values are misleading unless corrected for body size. By the early teens, boys average inches taller and pounds heavier than the girls. Being larger, they should have a higher oxygen consumption. Recalculating the data in terms of a uniform reference standard (such as weight or surface area) does reduce the sex difference somewhat, but does not eliminate it entirely. Over a ten year period basal oxygen consumption per kilogram of body weight drops nearly 50 per cent in both sexes. But it drops less rapidly in the male, as Lewis *et al.* (6) and others have noted, so that the oxygen consumption per unit of body weight is still about 10 per cent higher in nearly adult boys. Using weight or surface area as a reference standard eliminates some of the sex difference in the basal metabolic rate, but not all.

But equal weight or equivalent surface areas may mask differences in internal composition and this provides a possible explanation for the residual sex difference in basal oxygen consumption. As is now well known, boys differ from girls and men from women in the proportions of fat and muscle, and in the proportions of the several body fluids as well. As we have shown previously, muscle mass and oxygen consumption are highly correlated in this age group (4) and per unit of mass the male consists of more muscle with its high metabolic requirements and less of the metabolically less active fatty tissue. However, correcting for this difference in body composition does not eliminate the sex disparity in metabolism. A carefully matched series, pairing boys and girls almost exactly in calf-muscle size, still evidences the *usual* differences in oxygen consumption and in the *usual* direction. Despite the closeness of the matches (averaging within 1 per cent) both basal oxygen consumption and oxygen consumption per kilogram of body weight continue to be higher in the boys, and especially in the older boys. Boys tend to be bigger than girls. Boys, or at least older boys, contain more muscle and less fat than girls. Yet pound for pound, and pound of muscle for pound of muscle, the metabolism of the male exceeds that of the female, and to an increasing degree until the mature or "steady state" of growth and development.

Inasmuch as corrections for both body size and body composition fail to eliminate the familiar sex difference in the basal metabolic rate, it is well to consider other factors known to affect tissue metabolism. There is nothing at present that would suggest a higher level of thyroid activity in the male, though this cannot be discounted. But attention should be directed to the ketonic steroids (including the 17 ketosteroids) which rise above the minimum detectable levels at precisely the time when the metabolism curves begin to diverge (11). And it is known that many of these steroids are able to speed up the metabolic activity of muscle tissue. Here we have two possibilities. One is that ketonic steroids peculiar to the male underlie the differences in the basal metabolic rate observed here, and by many other workers. The other possibility is that quantitative differences in the level of metabolism-stimulating hormones are involved. Metabolic and endocrine studies on this group of boys and girls, which have been published elsewhere, favor the first alternative (2).

It should be emphasized, however, that the sex difference in metabolic activity is a real difference, and not just a byproduct of differences in size or internal composition. Though the male matures later than the female, his increased oxygen consumption begins early (pre-pubertally) and of course persists through adult life. The higher metabolic rate of the male may or may not account for the well-known sex differences in mortality and morbidity, or the familiar sex differences in overt behavior. But it is not something that can be factored away by the choice of a suitable reference standard.

Summary

1. In order to determine whether the sex difference in the basal metabolic rate could be explained in terms of body size and body composition, 409 determinations of basal oxygen consumption were made on 76 boys and 69 girls, including 27 pairs matched on the basis of muscle size.

2. In the age span 6-17, the males increased in basal oxygen consumption from 1,145 calories per 24 hours to 1,841, an increase of 60 per cent. The girls showed an increase of only 30 per cent in the same period.

3. Correcting for body size through the use of a uniform reference standard (calories per kilogram), the magnitude of the sex differences was reduced. However, the boys still exhibited a higher metabolic activity, especially in the older groups, with differences up to 10 per cent.

4. Although matching on the basis of muscle mass satisfactorily corrected for sex differences in body composition (namely muscle mass), the discrepancy in oxygen consumption remained, especially in the older group. With a mean difference of only .05 mm. in muscle size, the mean difference in oxygen consumption for the pairs (74.4 calories per 24 hours) equalled 6 per cent.

5. It was concluded that the higher level of metabolic activity in the male is not entirely due to his greater body size, or to his higher proportion of muscle per unit of mass.

6. Attention was directed to the metabolism-stimulating effect of certain steroid hormones, which may underlie the residual sex difference in basal metabolism, and to the epidemiological implications of the higher level of metabolic activity in the male.

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SEASONAL VARIATIONS IN PHYSIOLOGICAL FUNCTIONS DURING ADOLESCENCE

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Several reports dealing with seasonal variations in physical (9) and psychological (8) development have already appeared from the Institute of Child Welfare. This article reports the result of an examination of five aspects of physiological development during adolescence for evidence of seasonal variation. The five physiological measures are BMR, systolic blood pressure, basal pulse rate, respiratory rate, and basal oral temperature.

METHOD

The data upon which this investigation is based were collected during a longitudinal study of adolescence.[1] The subjects and general procedure are described in detail in a preceding article (2). Specific techniques of measurement are as follows: BMR was determined by the Tissot open circuit technique.[2] Respiratory rate was counted for one minute twice during each of the three gas sampling periods. Blood pressure was recorded at the first sound (auscultatory technique). Pulse rate was counted for a full minute. Oral temperature was taken for two minutes and then the thermometer returned for one minute and re-read for reliability. The entire procedure was repeated the following day.

Blood pressure and pulse rate were lowest during the first and second determinations made with the subject supine (18). Thus the average of these four measures (two each day) has been used since it presumably represents the closest approximation to truly basal measures. The mean of four measures was also used for body temperature. For BMR and respiratory rate the average of all six determinations has been used (16, 17).

RESULTS

Since it is known that there are individual and chronological variations in these physiological processes, it seemed poor tactics to search for clear-cut evidence of individual seasonal variations. Such an attempt also seemed unfeasible because of the fact that only two measures a year were taken. Finally, subjects who were measured only once a year would have had to be excluded, since in most cases the measures were taken in the same or

[1] Harold E. Jones directed the investigation. The physiological program was under the supervision of Nathan W. Shock. A general description of the study is to be found in (7).

[2] Details of the procedure are given in (17).

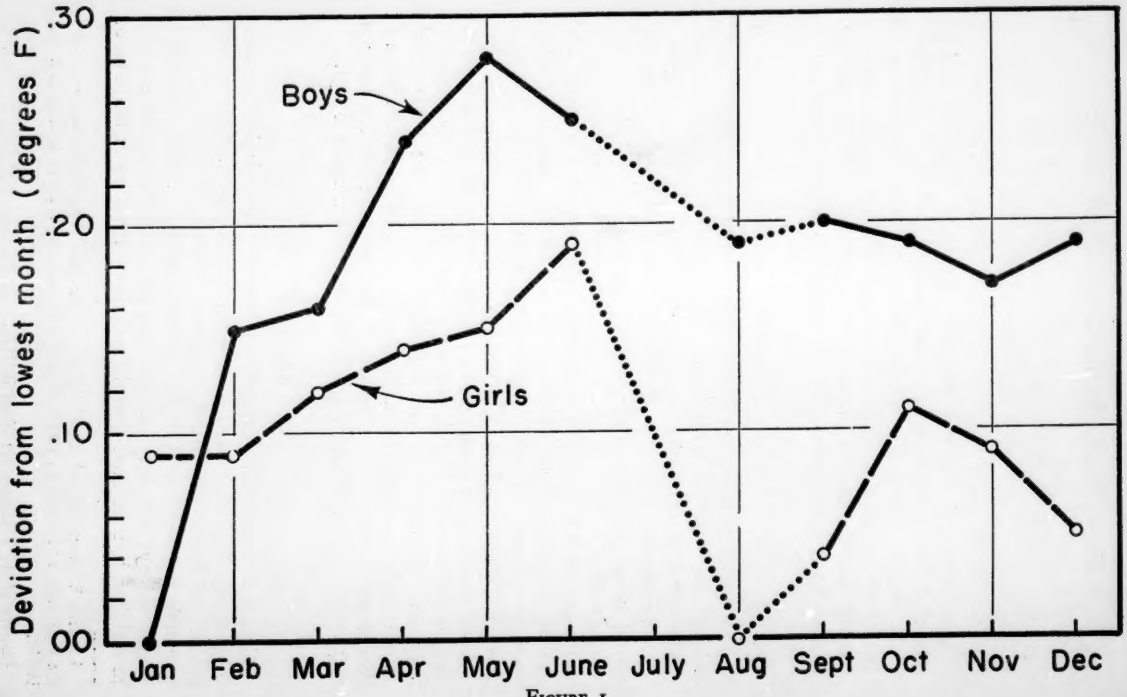
Deviation from lowest month (degrees F)
.30
.20
.10
00
Boys
Girls
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

FIGURE 1

adjacent months of consecutive years. Consequently, it was decided to group the data for all subjects for all years; that is, to combine all measures in a given month regardless of the subjects on whom they were made and regardless of the year in which they were made. Since most subjects missed one or more testing periods and also because subjects measured originally in (say) March and September were sometimes measured the following year in (say) April and October, there is a partial and varying overlap from month to month when the data are combined by months over all years as outlined above.

In order to overcome the statistical difficulties which arise from the overlap described above, two corrections were made in each measure for each child before the analysis of seasonal variations was undertaken.[3] First, an age correction was made. The regression on age of the variable under consideration was determined for each sex by the method of least squares, except for oral temperature in girls where linearity could not be assumed (2). This curve was fitted by eye. The mean at an arbitrary age was taken as a reference point. Then each measure for each child was corrected for the child's deviation from this age.

Following the age correction, the correction for individual differences was applied. Each measure for each child was corrected in terms of the deviation of the mean of that child's measures from an arbitrary reference point. For example, assume that the individual utilized as an arbitrary reference point for BMR has an average BMR of 42 calories per square meter per hour (after having been corrected for age deviations). Assume that the mean of a particular subject's BMR measures (each of which has been corrected for deviations from an arbitrary age) is 39, then each measure of BMR for this subject would be increased by three.

The first correction removes the systematic effect of age. The second removes the systematic effect of individual differences. Identical procedures were followed for all five physiological measures.

The twice corrected means for all five measures by month are given in Table 1. In Figures 1, 2, and 3 the deviations of the twice-corrected means are plotted as deviations from the lowest month. This method of plotting the data was chosen arbitrarily, since the twice-corrected means do not represent the true values of the measures at each month. Figures for respiratory rate and blood pressure have been omitted since in these functions there was no indication of seasonal variations.

Let us first consider Figure 1 and the question of seasonal variation in oral temperature. In spite of some irregularity in the curves, there is a rather clear general trend for oral temperature to rise during the spring and to decline during autumn. The "*F*" for seasonal variation in boys is 2.39. With 10 and 513 degrees of freedom this value is significant at the 1 per

[3] Dr. Rheem F. Jarrett suggested this approximate statistical procedure.

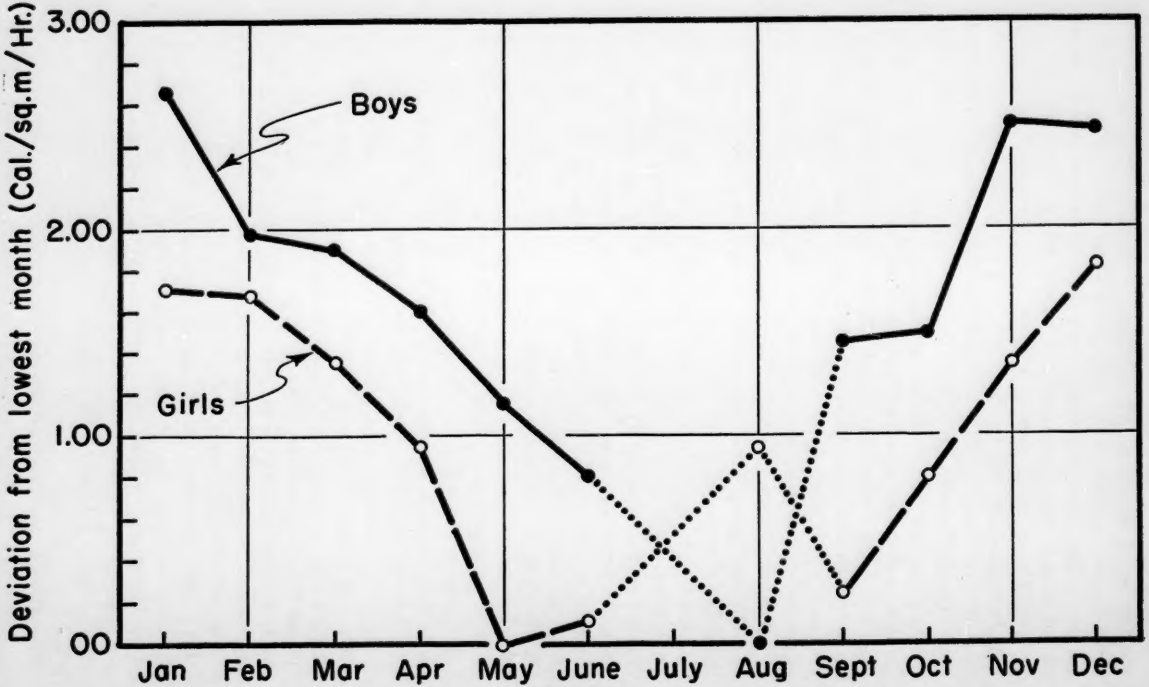
Deviation from lowest month (Cal./sq.m/Hr.)
3.00
2.00
1.00
00
Boys
Girls
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

FIGURE 2

TABLE 1

MEAN MONTHLY VALUES FOR FIVE PHYSIOLOGICAL MEASURES (CORRECTED FOR AGE AND INDIVIDUAL DIFFERENCES) EXPRESSED AS DEVIATIONS FROM LOWEST MONTH

	Body Temperature (degrees F)		*BMR* (cal/sqm/hr)		*Pulse Rate* (per min)		*Respiratory Rate* (per min)		*Systolic Blood Pressure* (mm merc)	
	N		*N*		*N*		*N*		*N*	
January										
Boys	44	.00	44	2.66	44	1.7	41	.13	44	1.4
Girls	43	.09	44	1.71	44	3.1	43	.71	44	1.3
February										
Boys	48	.15	48	1.98	48	2.3	48	.37	48	.8
Girls	45	.09	44	1.68	44	1.8	43	.00	44	2.0
March										
Boys	54	.16	55	1.90	55	1.6	52	.54	55	1.3
Girls	56	.12	59	1.36	59	1.9	62	.48	59	.9
April										
Boys	51	.24	51	1.60	51	.7	52	.28	51	.0
Girls	56	.14	56	.95	56	1.3	54	.30	56	1.3
May										
Boys	58	.28	59	1.16	59	1.8	53	.36	59	1.1
Girls	44	.15	44	.00	44	1.2	44	.59	44	.9
June										
Boys	14	.25	14	.81	14	.4	13	.63	14	4.2
Girls	10	.19	10	.11	10	.0	10	.30	10	1.9
August										
Boys	6	.19	6	.00	6	.0	6	.03	6	.5
Girls	7	.00	6	.94	6	1.7	6	.88	6	1.9
September										
Boys	62	.20	63	1.45	63	1.6	61	.35	63	.9
Girls	56	.04	57	.24	57	1.7	57	.25	57	.0
October										
Boys	66	.19	70	1.49	70	1.9	66	.36	70	.2
Girls	73	.11	73	.80	73	2.8	72	.30	73	1.0
November										
Boys	67	.17	65	2.50	65	3.0	64	.00	65	2.1
Girls	54	.09	55	1.35	55	3.3	54	.30	55	1.0
December										
Boys	54	.19	51	2.47	51	3.1	51	.69	51	1.2
Girls	38	.05	38	1.82	38	3.3	38	.38	38	1.4

NOTE—No measures were taken in July.

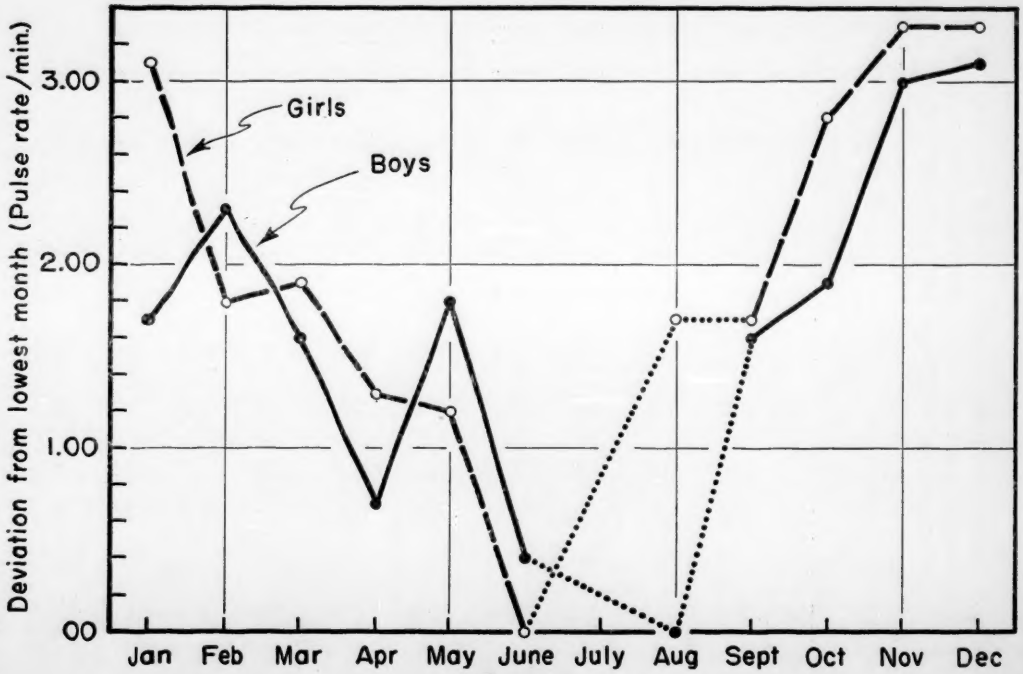
Deviation from lowest month (Pulse rate/min.)
3.00
2.00
1.00
00
Girls
Boys
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

FIGURE 3

cent level. The "*F*" for girls is .86, which is not significant with 10 and 471 degrees of freedom. A very low *eta* of .06 is significant.[4] Except for the June and August points which, unfortunately, are based on very small numbers of cases, there is only one serious departure from the general trend. The September point for the girls is very low. (The January point for boys is so different from both December and February as to be puzzling, but it is not a reversal.)

Figure 2 presents the twice-corrected means for basal metabolic rate. The great consistency of these curves leaves little doubt that there is a true seasonal variation.[5]

The curves in Figure 3 present the results of the analysis of pulse rate. They follow those for BMR rather closely, showing the same decline throughout the spring and the same rise throughout the autumn.[6]

As can be seen from Table 1 there is no indication of seasonal variation in either respiratory rate or systolic blood pressure.

Discussion

The rank order correlation coefficients between average monthly environmental temperature and the average values of the twice-corrected physiological measures are as follows:

	Boys	*Girls*
Temperature × Pulse Rate	—.56	—.67
Temperature × BMR	—.90	—.89
Temperature × Oral Temperature	+.75	+.35

While the number of cases upon which each correlation is based is very small, ten, (the August points were not used since they are based on very few observations) they suggest a straightforward interpretation in terms of seasonal change in environmental temperature. Thus, as environmental temperature increases, the body loses less heat, body temperature rises, and heat production and BMR decrease. The known proportionality between pulse rate and metabolic level (1) is reflected in the striking parallel of

[4] Our statistical procedure is not entirely satisfactory. We have run a straightforward analysis of variance with the twice-corrected measures. We have assumed the total degrees of freedom, to be equal to the total number of (twice-corrected) measures (524 for boys, 482 for girls) minus 1, or 523 for boys and 481 for girls. Ten degrees of freedom are lost to the months, which leaves 513 for the within months variance estimated for boys, and 471 for girls.

[5] Analysis of variance yields an "*F*" of 3.09 for boys and 4.00 for girls. With 10 and 515 degrees of freedom for boys and 10 and 475 for girls, these values are significant at approximately the 0.1 per cent level.

[6] Analysis of variance yields an "*F*" of 1.90 for boys and 2.12 for girls. With 10 and 515 degrees of freedom for boys and 10 and 475 degrees of freedom for girls, these values are significant at the 5 per cent level.

these two curves. Such an explanation is consistent with a number of previous studies of variation in body temperature as a function of environmental temperature (1, 11) as well as with investigations (3, 4) which have reported high BMR's in winter and low BMR's in summer. In addition, the explanation in terms of environmental temperature accounts for data from the southern United States which indicate average BMR values of from —6 per cent to —18 per cent (1, 5, 13). Finally, the lesser seasonal variation in temperature and BMR among girls is consistent with the observations of Hardy, Milhorat and DuBois (6) regarding sex differences in adjustment to environmental temperature. We have previously suggested (2) that this sex difference may be partly due to the insulating effect of subcutaneous fat in girls.

The environmental hypothesis does not account for the absence of seasonal variation in respiratory rate and systolic blood pressure. However, since except at extreme temperatures only 12 per cent of the heat loss in man is due to vaporization from the lungs (1) it may well be that within the rather narrow range of temperature variation in the San Francisco Bay region no significant effects in respiratory rate should have been expected. With regard to blood pressure, if there were changes in peripheral resistance due to vasoconstriction and vasodilation they were not reflected in pressure in a major artery.

While the environmental temperature hypothesis has a number of advantages it does not account for irregularities in the seasonal curves. Among these are the very low point for boys' temperature in January and the low September point for girls' temperature (see Figure 1). If the unreliable June and August points are omitted, the variation in temperature amounts to less than three-tenths of a degree Fahrenheit in boys and approximately one-tenth of a degree in girls. The total variation in BMR is less than two calories per square meter per hour. For pulse rate the total variation is about two beats per minute. These slight changes are probably of little clinical interest. However, if an environmental temperature hypothesis is correct, it is quite possible that in regions where the seasonal changes in climate are greater than in the San Francisco Bay area these changes might become matters of some importance.

The observed seasonal variations might be a function of some other seasonal variable than temperature such as change in amount of sunlight. If this interpretation is correct, then persons living in geographical locations with different climates but similar latitudes, e.g. Great Britain and central Saskatchewan, should show similar seasonal variations in these measures. If the relevant factor is environmental temperature, then greater seasonal variation ought to be found in areas where the seasonal temperature variations are greater, e.g. Saskatchewan.

An alternative interpretation has been suggested by Nylin (12) who found higher BMR's and accelerated growth in stature among Swedish children

during the periods from March to May and from November to January. He has advanced a growth rhythm hypothesis to account for the correspondence. Such an hypothesis probably will not account for our data since most investigations in the United States suggest that if there is seasonal variation in statural growth the highest rates occur during the spring and summer when these subjects have decreasing BMR's. Further, Jones (9) has shown that for these subjects the maximum increments in strength also occur during the spring. Finally, both Marshall's summary of American research (10) and the work of Reynolds and Sontag (14) suggest that increments of weight are minimal during the spring and early summer. Clearly, the simple relationship between BMR and indices of growth that is implied by Nylin's hypothesis will not account for all the facts. A paper now in progress will examine the relationship of the variations in the measures reported here with the increments in height and weight of these subjects.

Summary

We have examined BMR, oral body temperature, basal pulse rate, respiratory rate, and systolic blood pressure for evidence of seasonal variation during adolescence. We find fairly clear evidence of a fall in BMR and pulse rate during the spring, followed by a rise during the autumn. Tentative evidence of an opposite effect in body temperature in boys, but not in girls, has been reported.

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ORAL TEMPERATURE AND SUBCUTANEOUS FAT DURING ADOLESCENCE

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Oral temperatures and measures of subcutaneous fat for boys and girls of the Adolescent Growth Study of the University of California's Institute of Child Welfare are reported. The relationship of temperature to subcutaneous fat, BMR, and to the menarche is analyzed.

METHOD

All of the data have been obtained from the files of the Adolescent Growth Study[1] (6). Fifty-three boys and fifty-two girls representing a cross section of five elementary school districts in Oakland, California, were tested and measured at approximately six month intervals from 1933 to 1938. The mean age at first testing was 11.87 years. Children were selected for the study on the basis of the willingness of their parents to cooperate in a long term investigation and the probability of permanent residence in the area.

Oral Temperature

Oral temperatures were included in a battery of physiological measures made at the laboratory on two successive days each semester. The subjects were brought from their homes by automobile at 7:30 a.m., before breakfast. After determinations of blood pressure and pulse rate were made, the subject lay on a cot for twenty minutes while oral temperature was taken and three additional measures of pulse rate and blood pressure were made. A Siebe-Gorman half mask was then adjusted, and after a ten-minute respiratory adjustment period, the first of three eight-minute determinations of BMR was begun. A second reading of temperature was taken after the last BMR measure. The temperature determinations were made with a clinical thermometer which was held under the tongue for two minutes. The reading was taken and the thermometer was returned to the mouth for an additional minute to check reliability. The oral temperatures reported here are the average of four readings, i.e., determinations before and after the BMR measures on two successive days.

Subcutaneous Fat

Measures of subcutaneous fat were obtained during the semi-annual physical examination while the subject was sitting on the examining table.

[1] Harold E. Jones directed the investigation. Nathan W. Shock was in charge of the physiological data collection. The anthropometric program was administered by Herbert W. Stolz.

The measurements were made with Franzen calipers in three areas: on the anterior surface of the left arm over the biceps; on the abdomen to the left of the umbilicus; and over the crest of the left ilium. Since the calipers measure a fold of tissue the measures, in millimeters, are twice the actual thickness. The values reported here are the sums of these three measures.

TABLE 1

MEAN ORAL TEMPERATURE (DEGREES F.) BY AGE IN YEARS

	Girls			Boys		
Age	*N*	*M*	*S.D.*	*N*	*M*	*S.D.*
11.5	22	98.01	.35	25	97.86	.44
12.0	46	97.87	.41	39	97.89	.37
12.5	45	97.84	.33	53	97.95	.37
13.0	52	97.95	.23	43	97.83	.20
13.5	48	97.98	.35	49	97.90	.37
14.0	51	98.00	.40	46	97.73	.46
14.5	48	97.98	.34	51	97.79	.40
15.0	36	98.03	.46	41	97.57	.44
15.5	28	97.96	.27	41	97.59	.48
16.0	29	97.88	.43	32	97.46	.51
16.5	28	97.80	.39	34	97.39	.51
17.0	27	97.79	.43	29	97.44	.47
17.5	13	97.75	.37	16	97.42	.58

RESULTS

Age Trends and Sex Differences in Oral Temperature

Figure 1 shows the mean oral temperature for each sex separately, plotted against age. Smoothed curves are also shown. The smoothed curve for boys was determined by the method of least squares on the assumption of linearity, while that for girls was fitted by eye because linearity could not be assumed.[2] Table 1 gives the empirical values of the means and standard deviations for each sex at each age.

[2] We know of no fully appropriate statistical method for dealing with these data. As is inevitably the case with longitudinal studies, there is a partial and varying overlap of cases from year to year. Examination indicates that the irregularities in the regression on age are not due to the same few high individuals being measured at some ages and a different few low individuals being measured at others. If one were to assume independence of the individual determinations, *eta* (for girls) would be .35 and significantly different from *r* (—.10). While such a procedure is not exact we feel curvilinearity the best assumption to make.

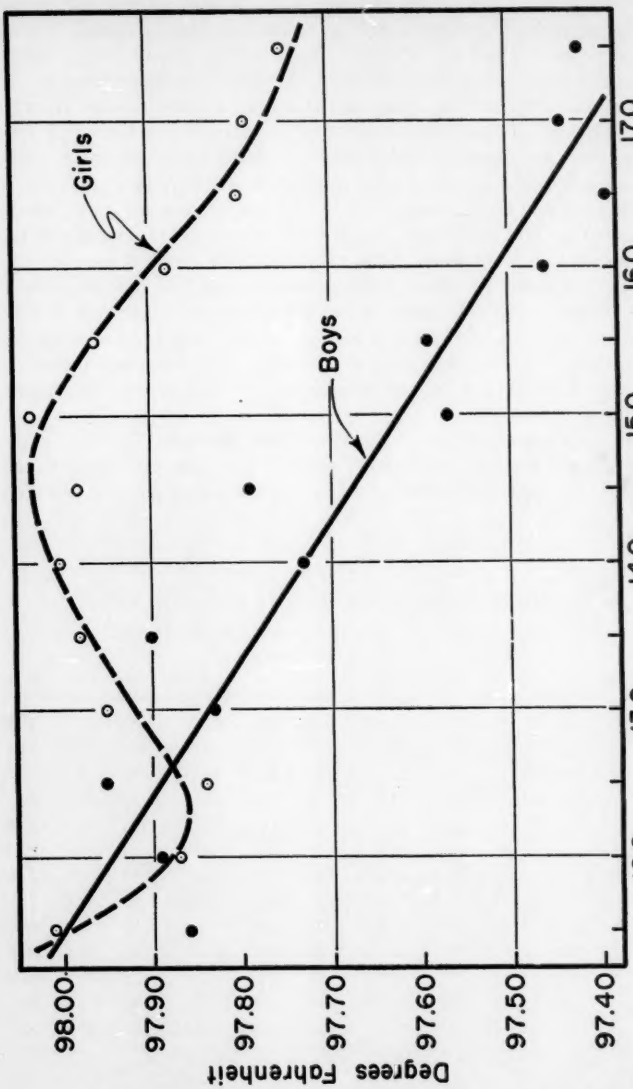

FIGURE 1—Mean Oral Temperature (in degrees Fahrenheit) as a function of age.

It will be noted that every mean is below 98.6 degrees Fahrenheit, a commonly accepted normal oral temperature. It is of interest that several investigators (1, 5, 7) have found the oral temperature of normal subjects under ordinary conditions of daily living to average considerably less than 98.6° F. Further, it is well established (2) that body temperature is at a minimum in the early morning. Iliff and Lee (4) have recently reported this phenomenon in adolescents observed under conditions similar to ours. In addition, our means probably reflect the basal conditions under which the subjects were measured and the fact that values for various physiological measures among trained subjects are usually lower than those for untrained subjects (2). This interpretation agrees with Shock's (11) finding that the BMR's for these subjects are lower than previously reported norms.

A second matter of interest is the systematic decline of oral temperature with increasing age. This trend is particularly marked in the case of boys. Between 12½ and 17½ there is a drop of approximately half a degree Fahrenheit. Our data thus confirm a similar trend recently reported by Iliff and Lee (4) and are consistent with a decline in oral temperature said to occur over an even longer age span (10).

The girls' age trend apparently differs from the boys'. The boys' curve approximates linearity, whereas the girls' is more complex. For girls, an early decline appears to be followed by a two and a half year rise and then

TABLE 2

MEAN SUBCUTANEOUS FAT OF GIRLS BY AGE IN YEARS

	Physiological Group			Non-Physiological Group			Total		
Age	*N*	*M*	*S.D.*	*N*	*M*	*S.D.*	*N*	*M*	*S.D.*
10.5	10	76.4	17.4	8	65.8	11.0	18	71.7	15.8
11.0	26	74.6	20.8	19	75.3	16.4	45	74.9	19.1
11.5	32	77.7	20.4	24	82.6	16.8	56	79.8	19.1
12.0	39	82.6	23.8	33	79.6	14.8	72	81.3	20.2
12.5	45	81.3	22.4	34	81.6	15.6	79	81.4	19.8
13.0	45	84.8	24.5	39	85.1	16.9	84	85.0	21.3
13.5	46	89.0	21.6	37	88.5	22.0	83	88.8	21.8
14.0	47	88.4	21.7	35	86.3	19.6	82	87.5	20.9
14.5	44	92.0	20.2	37	87.4	15.6	81	89.9	18.4
15.0	39	92.2	22.8	36	88.7	16.9	75	90.5	20.3
15.5	38	93.3	19.0	34	89.2	14.5	72	91.3	17.2
16.0	26	93.5	21.9	17	90.5	18.4	43	92.3	20.6
16.5	7	88.9	43.3	11	96.6	20.7	18	93.6	31.7

NOTE—Tables 2 and 3 give comparable data for a control group for whom no physiological measures were gathered.

TABLE 3

MEAN SUBCUTANEOUS FAT OF BOYS BY AGE IN YEARS

	Physiological Group			Non-Physiological Group			Total		
Age	*N*	*M*	*S.D.*	*N*	*M*	*S.D.*	*N*	*M*	*S.D.*
10.5	17	44.4	9.4	13	47.5	11.9	30	45.7	10.7
11.0	37	44.4	11.2	25	46.5	10.5	62	45.2	11.0
11.5	47	46.5	12.9	34	47.7	10.2	81	47.0	11.8
12.0	48	48.7	12.8	40	47.2	10.7	88	48.0	12.0
12.5	48	48.8	11.3	41	47.5	7.8	89	48.2	9.9
13.0	50	48.7	12.4	42	46.8	7.6	92	47.8	10.4
13.5	51	48.0	11.8	41	46.0	7.0	92	47.1	10.0
14.0	49	47.4	11.5	40	44.6	5.8	89	46.1	9.6
14.5	49	46.1	9.8	37	43.5	5.1	86	45.0	8.2
15.0	49	46.1	9.7	37	43.7	5.1	86	45.0	8.5
15.5	46	44.8	9.6	31	43.0	4.0	77	44.0	7.8
16.0	39	44.6	10.0	33	42.4	5.6	72	43.6	8.4
16.5	46	45.6	9.0	33	43.4	7.1	79	44.7	8.3
17.0	46	45.1	8.5	32	45.3	7.3	78	45.2	8.0
17.5	37	47.5	10.2	24	46.3	5.6	61	47.0	8.7
18.0	24	48.0	10.2	13	47.5	6.1	37	47.9	9.0

a second decline from age 15½ onward. Although Iliff and Lee (4) did not find such a reversal, the regression in our data apparently is curvilinear.[2]

An additional fact appearing in Figure 1 is the consistently higher oral temperatures of girls as compared with boys. While the consistency is limited by the fact that the samples at various ages are not independent, the fact remains that the mean difference of .23 degrees is significant[3] at well beyond the 1 per cent level. Further, this difference appears at the same age, 13, as it did among the Iliff and Lee subjects and, as in their subjects, is maintained thereafter.

Age Trends and Sex Differences in Subcutaneous Fat

In their investigations of temperature regulation Hardy, Milhorat and DuBois (3) and DuBois (2) have demonstrated that women are better insulated by skin and subcutaneous tissue than men. It seemed possible to us that this sex difference in insulating tissue might help to account for the

[3] "*t*," computed by determining the mean temperature for each child and then finding the overall mean sex difference, equals 3.2 with 103 degrees of freedom. The separate "*t*'s" for sex differences are not significant until age 13, where the difference is significant at the 5 per cent level. From age 14-17 the differences are significant at or beyond the 1 per cent level.

higher temperatures found in girls. Further, the reversal in the downward age trend for temperature in girls may be due to girls' tendency to add large increments of insulating fatty tissue during adolescence.

In order to test the hypothesis that body temperature is related to amount of subcutaneous tissue, we first computed the sums of the three measures of fat for each individual for each age. These normative data will be presented first. Tables 2 and 3 give the means and standard deviations of the distributions for each sex at each age. The measures for girls are curtailed at the older ages because the measures at these ages were made by a different examiner. Although this examiner's measures were reliable within themselves, they differed significantly from those of the previous examiner and have been omitted.

The age trends and sex differences are remarkably similar to those found by Reynolds (8), who used a much more exact technique of measurement. The girls show increasing amounts of subcutaneous fat up to age 16. Unfortunately, we are unable to report on later ages among girls due to the change in examiners. The boys' trend is curvilinear, rising to age 12, declining from 13 to 16 or 17, and rising thereafter. This trend also parallels

TABLE 4

CORRELATIONS AT SUCCESSIVE AGES BETWEEN TEMPERATURE AND FAT

	Girls				Boys	
	Examiner I		Examiner II			
Age (years)	*N*	*r*	*N*	*r*	*N*	*r*
11.5	12	+.04			13	+.32
12.0	27	+.02			37	−.04
12.5	38	−.17			40	−.03
13.0	37	+.18			46	+.50**
13.5	37	+.11			44	+.17
14.0	43	+.17			45	+.17
14.5	38	+.06			46	−.01
15.0	31	−.07			40	+.05
15.5	22	+.10			34	+.15
16.0	11	−.04	9	+.49	31	+.60**
16.5			18	+.26	33	−.02
17.0			25	+.41*	30	+.27
17.5			14	+.20	17	+.04

Note—Because of the change in examiners noted previously, there are two series of correlations for girls at the older ages.

* $P < .05$.

** $P < .01$.

TABLE 5

DISTRIBUTIONS OF "WITHIN-INDIVIDUALS" CORRELATIONS BETWEEN TEMPERATURE AND FAT

r	*Girls*	*Boys*
+.9	1	1
+.8	1	0
+.7	0	1
+.6	1	1
+.5	6	4
+.4	3	4
+.3	6	3
+.2	2	4
+.1	7	4
+.0	4	5
—.0	3	5
—.1	3	4
—.2	0	2
—.3	4	4
—.4	3	3
—.5	3	1
—.6	1	3
—.7	3	3
—.8	1	0
—.9	0	0
N	52	52
N+	31	27
N—	21	25
Mdn.	+.1	+.0
P	<.20	....

and confirms Reynolds' trend at the older ages where he had few subjects. The girls consistently show greater amounts of subcutaneous fat than do the boys, and this difference increases until at least age 16. Although in our group the size of the difference is a function of the fact that different examiners were used for each sex, the general difference between sexes is too well established to be questioned.

Relationship Between Oral Temperature and Subcutaneous Fat

If the hypothesis that differences in body temperature are at least partially due to differences in insulating subcutaneous tissue is correct, then one might reasonably expect parallels between these two measures. Three possible approaches suggest themselves: comparison of the age trends, correlation coefficients computed at each age, and correlations within each individual over time.

Comparison of Table 1 with Tables 2 and 3 indicates no parallel in the age trends for either boys or girls. The correlations at each half-year age interval are listed in Table 4. While there is a predominance of positive correlations, no clear-cut trend is apparent and only three of the coefficients are statistically significant (age 17 for girls and ages 13 and 16 for boys). The distributions of the correlations for each individual are given in Table 5. For boys, the median correlation is essentially zero. For girls, the median correlation is very low but positive.[4] In brief, neither the correlations within individuals nor the correlations at different ages lend strong support to the hypothesis that the reversal in the downward trend of girls' temperature is due to the insulating effect of fatty tissue. At best the evidence is only suggestive.

TABLE 6

CORRELATIONS AT SUCCESSIVE AGES BETWEEN BMR AND TEMPERATURE

Age (years)	*Girls*		*Boys*	
	N	*r*	*N*	*r*
11.5	14	+.37	16	+.12
12.0	29	+.43*	37	+.37*
12.5	43	+.25	44	+.54**
13.0	39	+.06	45	+.01
13.5	44	+.09	45	+.06
14.0	45	+.28	45	+.09
14.5	41	+.17	47	−.03
15.0	34	+.20	41	+.08
15.5	31	+.18	35	+.36*
16.0	23	+.49*	34	−.01
16.5	25	+.28	33	+.00
17.0	28	+.05	30	+.17
17.5	19	+.21	23	+.22

* $P < .05$.

** $P < .01$.

Relationship Between Oral Temperature and BMR

Although Shock's BMR norms for these girls (12) show no reversal corresponding to the one found in temperature, some of the individual curves (12) do suggest such a phenomenon. Therefore, the correlations between oral temperature and BMR at different ages, and correlations between oral temperature and BMR for each subject individually were computed. The correlations at each age are given in Table 6. For girls, all the coefficients are positive, although only two of them, age 12 and age 16,

[4] The probability of obtaining 59 per cent positive correlations by chance is .10 (one-tailed test).

TABLE 7

DISTRIBUTIONS OF "WITHIN-INDIVIDUALS" CORRELATIONS BETWEEN TEMPERATURE AND BMR

r	*Girls*	*Boys*
+.9	1	1
+.8	0	1
+.7	2	3
+.6	3	5
+.5	1	3
+.4	3	4
+.3	6	4
+.2	1	9
+.1	4	4
+.0	4	2
—.0	9	9
—.1	1	1
—.2	6	1
—.3	1	3
—.4	3	0
—.5	3	0
—.6	3	1
—.7	0	1
—.8	1	0
—.9	0	0
N	52	52
N+	25	36
N—	27	16
Mdn.	—.0	+.2
P	....	<.01

reach significance at the 5 per cent level, using a two-tailed test. For boys, eleven of the thirteen are positive and three (12, 12.5, and 15.5) are significant.

The distributions of individual correlation coefficients between temperature and BMR are given in Table 7. For girls the median value is zero, while for boys it is low, but positive.[5] Thus the positive evidence provided by the correlations at separate ages is not confirmed for girls, but it is confirmed for boys.

[5] The probability of obtaining 69 per cent positive correlations by chance is less than .01.

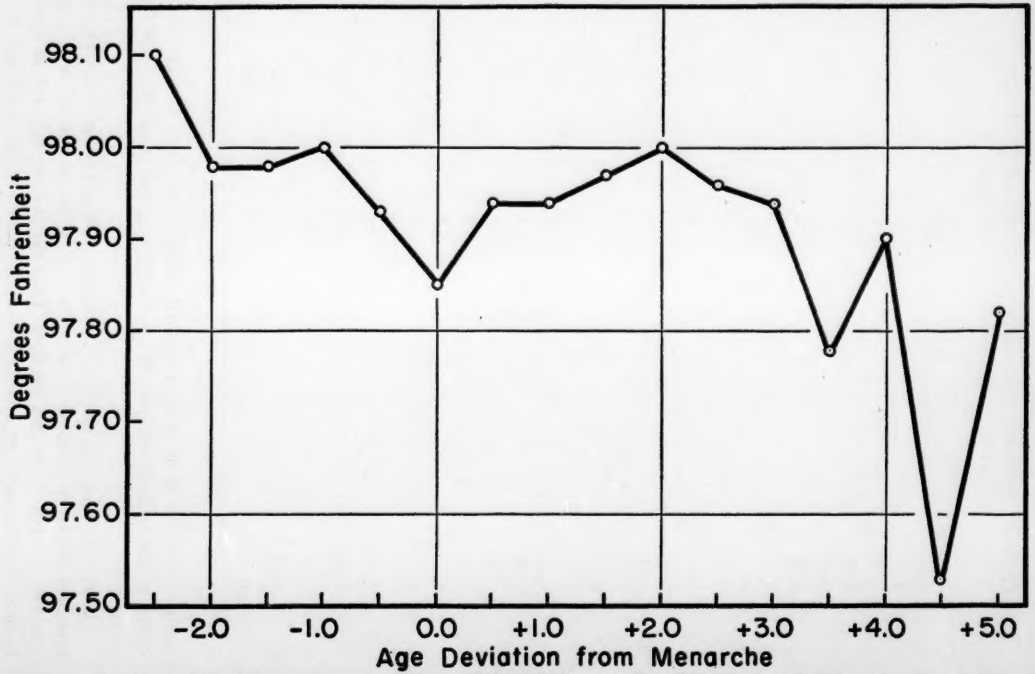

FIGURE 2—Mean Oral Temperature (in degrees Fahrenheit) as a function of age deviation from menarche.

Relationship Between Oral Temperature and the Menarche

Shock (12) has shown that for several aspects of physiological development age deviation from menarche is a more meaningful index of developmental status than is chronological age. Since body temperature is known to be related to the menstrual cycle (9) and since the reversal in the downward trend of body temperature takes place during the age range when most of these subjects reached the menarche the data were retabulated in terms of age deviation from menarche. Figure 2 shows the temperature means plotted against age deviation from menarche (ADM). The reversal in downward trend of oral temperature does occur at the menarche; thereafter the trend is upward for two years. Table 8 lists the means and standard deviations.

TABLE 8

MEAN ORAL TEMPERATURE BY AGE DEVIATION FROM MENARCHE

ADM (years)	*N*	*M* (° F.)	*S.D.*
−2.5	10	98.10	.21
−2.0	10	97.98	.27
−1.5	16	97.98	.30
−1.0	27	98.02	.27
−0.5	39	97.93	.35
0.0	41	97.85	.37
+0.5	43	97.94	.33
+1.0	43	97.94	.37
+1.5	41	97.97	.49
+2.0	39	98.00	.42
+2.5	36	97.96	.39
+3.0	25	97.94	.35
+3.5	24	97.78	.46
+4.0	16	97.90	.40
+4.5	13	97.53	.38
+5.0	8	97.82	.40

DISCUSSION

The decline in temperature for both boys and girls and the higher temperature of girls are supported by data from other investigations. However, interpretation of these findings is somewhat difficult.

We examined the relationship between oral temperature and several other variables which seemed likely to be pertinent. It seemed possible that the sex difference in oral temperature might be due to sex differences in

insulating fatty tissue, but no parallel was found in the age trends in these two variables. Correlational techniques yielded slight indications of a positive relationship between these two variables in girls, but not in boys. Possibly the amount of subcutaneous tissue is too small in boys to have a measurable effect, but this is only conjecture.

In the case of the relationship between temperature and BMR the positive evidence is largely restricted to boys. For boys, the age curves for oral temperature and BMR are roughly parallel and both the individual correlations and the correlations at different ages tend to be positive. For girls, however, the temperature age trend exhibits a reversal which is not found in the BMR data and although the correlations at different ages are positive, the individual correlations center around zero.

Finally, we examined the possibility that the menarche is a complicating factor in the age trend in girls' temperature. Oral temperature plotted in terms of ADM does indicate a possible relationship. The early decline ends at the menarche. However, this gives us no explanation for the following rise and fall.

None of the relationships between temperature and other variables are sufficiently clear-cut to convince. No single variable studied will account for age trends in both sexes, for sex differences, and for the reversal in age trend among girls. It may be that temperature levels in girls are more influenced by subcutaneous fat and subject to variation with the menstrual cycle, whereas in boys, in whom the amount of subcutaneous tissue is comparatively small and changes less with age, BMR is a more important factor. However, the extent of these relationships is so slight that an entirely different hypothesis may be required.

Summary

Age trends and sex differences in oral temperature and subcutaneous fat among 53 boys and 52 girls measured from approximately age 11 to age 18 were examined.

Oral temperatures declined during this age period in both sexes, the decline being more marked, and approximately linear in boys. Among girls the decline was reversed between the ages of 13.0 and 15.5. After age 13, the girls' oral temperatures were significantly higher than the boys'.

No relationship between oral temperature and subcutaneous fat was observed in boys. Indications of a positive relationship were obtained in girls. Little relationship between oral temperature and BMR was observed in girls. Indications of a positive relationship were obtained in boys.

When oral temperature was considered in relation to the menarche, it was found that the early decline in temperature reversed itself at the menarche, rising for about two years thereafter before resuming the decline.

Subcutaneous fat in girls increased until the age of 16. Among boys, subcutaneous fat showed comparatively little systematic variation with age. The trend was curvilinear, increasing to age 12, declining somewhat from 13 to about 17, and then increasing again to 18.

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WHY AN INTERDISCIPLINARY SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT [1]

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Two years ago its president, Dr. L. W. Sontag, addressed this Society, tracing its evolution and questioning how to re-invigorate the group. His over-view clearly reflects the social change which is of major concern to us —the decreasing attention given to child development as a common focus of several disciplines.

Child psychologists are also currently concerned with the apparent lack of vigor in their field. At one time many psychologists thought that the description of the growth process would give them something unique, which a study of behavior modifications in rats or adult men could not give. They looked to comparative, experimental embryology and to patterns of human growth to provide the principles or concepts about which they could organize their thinking concerning behavior change. A striking feature of current child psychology literature is the absence of discussions of growth or of the use of growth concepts in an attempt to organize thinking about child behavior. In current psychological discussion there is little awareness of research on hormones or of modifications of diet, as these factors may relate to behavior.

Here has been the traditional contribution of the Society for Research in Child Development. Under the auspices of this organization, bodies of research material based on physiological processes have been brought to the attention of psychologists and educators, sociologists and nursery school teachers, and *vice versa,* the concern with the child as a learning organism in a social world has been brought to the attention of biologists and anatomists, orthodontists, and biochemists. Despite expressions of dissatisfaction with our efforts, of lack of common language or integrated theory, this has not been an insignificant achievement. There are many demonstrations for example, that the child psychologist who has been active in the Society for Research in Child Development is aware, as other child psychologists are not, of literature in related areas, and of concepts in other disciplines which have fruitful impact on his own thinking. More often than not, such a psychologist has a broader view of the child as a growing, changing organism and especially of the significance of research findings for practical

[1] Paper read at the 1952 meeting of the Society for Research in Child Development, Yellow Springs, Ohio, March, 1953.

matters of child nurture and guidance than his colleague of somewhat more restricted training.

The interdisciplinary idea is not dead. Since 1946 there has arisen in practically every major university a center or laboratory for research in human relations, or social behavior, or social relations. One and all, these are interdisciplinary efforts in the broad field of social science. Everyone agrees that in an age of rapidly multiplying data and overlapping areas of concern, we ought to achieve more integration, more concerted attack on common problems.

Perhaps we now lack the sense of mission which gripped our field in its earlier days; perhaps we are not so sure that through facilitating child growth we can attain the "Good Society." Our currently popular interdisciplinary efforts appear to be searching for principles of group life—social, economic, political—which when properly manipulated and applied will attain at least a better Society. Studies of child behavior in the group, under this new approach search also for these general principles. There is less concern with childhood for its own sake, on the assumption that a good childhood insures good adult living.

Dr. Sontag pointed out that lack of venerable academic tradition has handicapped us. An expert is truly expert in only a limited area, and often he gets his greatest professional recognition and satisfaction in an "old line" department. This problem has troubled the various child development institutes, and some of the newer centers for interdisciplinary effort in the social sciences report growing awareness of this same problem. They too, may repeat our developmental cycle, find themselves lacking a first row chair at the academic council tables, fail to preserve their sense of mission, and may in time hold similar progress and planning sessions such as this one. I predict that others are and will be grappling with the sense of helplessness which seems to come with broad gauge interdisciplinary effort.

Several major attacks have been made on the serious problem of establishing among several disciplines a common floor on which to work. An approach which is currently being argued in psychology for the behavior sciences and which has many proponents, is the attempt to establish a hypothetico-deductive system with theorems and postulates marshalled in proper logical order, from which hypotheses can be stated which may be subjected to experimental test, in the usual logic of science. A number of such efforts toward unifying theory have taken place recently in the area of social relations, or social behavior. Participants in these efforts have sooner or later come to realize the tremendous difficulties involved in semantics, private meanings, and the perennial problem of perception which is contaminated by the preconceptions of the observer. Nor does a reorganization of terminology wipe out the impact of these private meanings and preconceptions, as much recent psychological research has shown. It has been argued that since these preconceptions inevitably condition the gathering of data it

becomes essential that the theory be worked out in the greatest detail before hypotheses are formulated. Professional literature is full of studies which have been subjected to the Procrustean bed of theoretical terminology and made to demonstrate the adequacy of new theory.

Others still urge the familiar approach of empiricism—that we come together at the point of methodology, of operations concerned with data gathering. While it may well be that further multiplication of empirical fact is indeed "beating a dead horse," it can scarcely be denied that in the operations the scientist goes through in defining and measuring his variables there can be somewhat greater agreement than in the development of new systems of abstract terms in an effort to get rid of the freight of old meanings.

A third approach has been the attempt to concentrate on the whole child. Most of us are agreed that one cannot really attend to the whole child—he evades you. We need a process of analysis followed by one of synthesis. The initial broad, broad look never turns up much of significance. One has to focus, and focus again, here and there, and then stand back to observe the areas which he has studied in pin-point detail against the larger body of phenomena which the broader look reveals. We no longer pay much attention to the earlier literature on the "whole child." We recognize that one cannot attain scientific excellence as an expert on the whole child. Indeed, excellence in one's own field, as we remarked earlier, may become something of a deterrent to interdisciplinary effort. The competent person doesn't want to be bothered doing things he cannot do well. This, however, is no argument against the activities of the Society for Research in Child Development. A very competent person coming to another area new to him, even though an amateur, can usually (*a*) raise good questions, (*b*) see "simple-minded" relationships, (*c*) appreciate honesty, scientific caution, and methodological exactness, and (*d*) share in a cooperative spirit of interest arising out of curiosity and the spirit of inquiry which is so characteristic of good science. To provide such opportunities seems to me to be a continuing service of the Society for Research in Child Development.

What suggestions can we make? Two years ago Dr. Sontag believed that we should go to other professional societies, taking our work and interests to their sessions. We have not yet had sufficient time to undertake and to evaluate this procedure. If it should result in only the members of that society attending the joint meeting, we would not of course attain our goal. Perhaps there are undertakings which we as a Society could sponsor which would occur outside of meetings. Perhaps committees of our own membership could undertake to publish within our own journals systematic, scholarly cross-disciplinary reviews of research findings. We continue to need searching surveys of the literature, by area or topic, in an attempt to bring together what we know, critically evaluate it, and indicate the gaps in knowledge. I refer to the type of review which appears in Carmichael's

Manual of Child Psychology (2) and an occasional example of which has appeared in our own Monograph series. These would be scholarly works for scholars.

As is so often the case for sciences which deal with human welfare, our chief consumers consist of the applied folk—educators, teachers, home economics people, pediatricians, parents. These people do not do research themselves, and are not always able to read with understanding our technical documents. But they are eager to improve understandings which grow out of these technical documents and to apply the practical outcomes of research. They will expect useful materials, whether from bodies of empirical norms, or from confirmed or rejected hypotheses which permit greater control of the kinds of behavior they seek to promote.

Some of us ought occasionally to write interpretive articles, or articles which point out the implications as we see them of bodies of research material. These articles should, of course, be published where they will be available to the consumer. If we do not find this to our liking, perhaps we can encourage some of our students to undertake this task, but it is a useful learning experience to force oneself to raise the question "so what?" about some of his work. I say this with full cognizance of the importance of basic research, which attempts to solve no practical problem but merely to advance our understanding of fundamental principles of life processes. We are well aware of what a strictly utilitarian point of view does to science, but it is a chastening and perhaps useful experience to examine periodically one's own work and that of his colleagues with the question, "What does this add up to for human living?"

It may well be that such pulling together of data will force recalcitrant empiricists to reconsider the advantage of theory. On the other hand, such evaluative reviews may have a salutary effect on theory. A case in point is the present situation with respect to research on social behavior of children. Social class theorists and sociometricians are doing a great deal of work on the formation of groups, and the impact of groups on personality process with resulting development of social behaviors. Many of the conclusions emerging from such research, appearing as tests of hypotheses deduced from theory, are available in an earlier descriptive literature. Thorough acquaintance with this earlier literature might well save modern experimenters some time and perhaps much money.

Finally, I would suggest an attempt to develop occasional seminars which would introduce descriptive, systematic reviews of research from one area of study to people in other fields who have a concern with children. Social workers are currently most enthusiastic over an attempt by Otto Pollak and collaborators (6) to examine social science in relation to psychotherapy for children. This book seeks to explore and define the contributions of the behavior sciences to practice in a psychoanalytically oriented child guidance clinic. This project is in itself a case study of a staff seminar in one

institution and has been described as a major and outstanding success as a bridge of interdisciplinary gaps. The book is written strictly from the sociological and psychiatric point of view, with one chapter on psychological learning theory. It intentionally avoids the child development literature. The argument advanced for this neglect is that the scientific and quantitative character of the child development literature is discouraging to qualitatively trained social workers who are far more comfortable using descriptive and qualitative language. It is to be regretted that the selection of relevant behavior sciences and their insights was made principally in terms of "comfortable language." Some of us have not had the experience which Dr. Pollak describes. On the contrary, we have found that social workers, given insight into the power of predictive tools and quantitative methods, can become most enthusiastic about them. Pollak's book, it seems to me, is one of the best arguments for broad interdisciplinary seminars which would strive to teach the members of a profession some of the useful tools and concepts developed in another area.

These suggestions are mostly pleas for organizing, for synthesizing. Like many, I am impressed by the extent of our data, and the need to systematize it. Certainly many studies appear pointless; they have been "ground out," simply because it was possible to go through the motions of grinding. Yet, I am not ready to throw out the straight descriptive method. I would like to see some researchers continue to work with molar behaviors, with growth studies, with physiological studies. Perhaps as some hold today, the socially useful concepts *are* independent of a developmental process in which age change is a fundamental dimension. Yet social-psychological theories today are cast in the language of behavior modification. The child development point of view is usually concerned with this modification over a longer period of time than is recognized in many behavior studies.

I am not yet ready to throw out growth as an integrating concept in the child field together with the longitudinal method of studying process. Students of animal behavior who come from biology have long emphasized the need to observe the entire life development of species under a great variety of "natural habitats" before developing hypotheses which can be taken into the laboratory for crucial test. It is interesting to note that, in an attempt to describe the developmental process in mammals other than man, Scott and his co-workers (7) in the field of comparative psychology are now utilizing methods which were applied to children in an earlier period. In the field of child behavior we see Roger Barker (1) applying to children the methods and concepts of naturalistic observation and of ecology which have been so notably advanced by students of animal behavior such as Lorenz (4) and Tinbergen (8). Their hypotheses grow out of an intimate acquaintance with the varieties of behavior manifested by a species. Certainly the cultural anthropologist has represented this point of view, and Margaret Mead (5) goes so far as to argue for the substitution of years of

experience for scientific rigor—the experimentalist becoming his own instrument. Few of us would go quite this far, though some of us are a little baffled when we attempt to encompass the behavior of children as we know it within the neat and limited paradigms of the hypothetico-deductive system.

One difficulty revealed by the literature of modern psychological learning theory is the apparent lack of recognition of the complexity and of the reiterative, cumulative character of environment as far as children are concerned. The learning conditions set up by the experimentalist do not come anywhere near approximating the kinds of learning situations which children get themselves into every day. As many have pointed out, there is a tremendous amount of over-learning in many aspects of child's behavior which is never equalled in the laboratory, with human subjects at least. Animal ecologists recognize that cage born and bred animals may learn differently than do animals subjected to the variety of environing conditions found in the "natural" habitat.

Recently, Professor Harlow at Wisconsin has questioned the drive-reduction basis of learning, at least in primates (3). He points to the manipulative, investigative tendency characteristic of monkeys, and to an even greater extent of children. Nor does he seem to be willing simply to call this tendency another "drive." To encompass some of the behaviors observed in children as well as the thirst-hunger-sex drives investigated in rats, one must broaden and generalize the "need" concept so much as to be almost self-defeating. Harlow has also argued for "learning-sets"—that higher organisms, at any rate, "learn how to learn." If this is true, the learning performance is different at different stages of development, and principles established on a very simple organism might not apply to the learning of the same organism at a more complex phase of its development. To use such principles successfully at different levels of complexity one would have to generalize them so broadly that they could mean almost anything. In our earlier history this happened to concepts of "differentiation" and "integration." It may well happen to concepts of "need reduction," "primary and secondary generalization," "latent learning" and the like.

These are reasons why we should occasionally look beyond our own "systems" and regard the organism as broadly as possible as a possible cure for intellectual provincialism. We may not take the time to read each other's journals, but the round tables of an interdisciplinary society may well enlarge our intellectual life-space.

Let us have an extension of behavior theory and the vigorous prosecution of research along its lines. But let some continue, as does the students of comparative behavior, extensive, rigorous observation before taking hypotheses to the laboratory for test. I do not look for the early creation of an interdisciplinary "theory" of child development, applicable with equal facility by all the scientific interests represented here. I am sure that "theory-

conscious" thinkers in various areas can learn from observing the methods and operations of their colleagues in related fields. As a result of this wider awareness, the traditional emphasis of our Society, I believe that any scientific investigator will produce results which will more quickly have results for the common good.

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THE WISC AND THE SRA PRIMARY MENTAL ABILITIES TEST [1]

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This study gives some comparative information concerning two of the newer tests in the field of intelligence measurement, the Wechsler Intelligence Scale for Children (WISC) and the SRA Primary Mental Abilities Test (Elementary) for ages 7 to 11 (SRA).

Although both tests yield an IQ, they differ in many ways. Some of the essential differences are as follows: (2, 3)

1. The WISC is an individual test, while the SRA is intended for group administration.

2. The WISC consists of 12 subtests, 2 of which are considered as supplementary; these two supplementary tests were not used in this study. *Verbal* tests include general information, comprehension, arithmetic, similarities, and vocabulary. *Performance* tests are picture completion, picture arrangement, block design, object assembly, and digit-symbol.

The SRA consists of 5 subtests, each of which is designed to measure a separate "primary mental ability" — Verbal-meaning, Space, Reasoning, Number, and Perception.

3. The WISC yields a Total IQ, Verbal IQ, and Performance IQ. The SRA yields a total IQ, plus an IQ for each of the primary mental abilities tested.

4. WISC IQ's are obtained by comparing each subject's performance with scores earned by individuals in his own age group. SRA scores are obtained by comparing each subject's performance with scores earned by individuals in a composite age group.

The two general questions with which this study is concerned are:

1. To what degree and in what manner are the total IQ's yielded by these tests associated?

2. How do the SRA primary ability IQ's relate to the Verbal and Performance IQ's yielded by the WISC?

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[1] This article is based on a thesis submitted to the State University of Iowa in partial fulfillment of the degree of Master of Arts. The author gratefully acknowledges the helpful guidance of the late Dr. Beth L. Wellman and dedicates this article to her memory. Gratefulness is expressed also for the help of the other members of the faculty and staff of the Iowa Child Welfare Research Station; and to Dr. Herbert Spitzer, Director of the State University of Iowa University Elementary School, for permission to do research with the children enrolled there.

METHOD

Fifty children, ranging in age from 8 years, 5 months, to 10 years, 4 months, were given both the WISC and the SRA.[2] These children comprised the 3rd and 4th grades of the University Elementary School, State University of Iowa. They are of superior intelligence, and come from families of high socio-economic status.

The WISC and the SRA were administered to each subject within one month of each other. In order to balance the effects of having one test before the other, half of the children were given the WISC before the SRA, and half of them were given the WISC afterwards. These two groups were equated on the basis of age.

TABLE 1

COEFFICIENTS OF CORRELATION BETWEEN SRA PRIMARY MENTAL ABILITY IQ's AND WISC VERBAL AND PERFORMANCE IQ's

	WISC Verbal IQ	*WISC Performance IQ*
Space	.49	.34
Number	.15	.38
Reasoning	.63	.55
Perception	.18	.42
Verbal-meaning	.68	.40

RESULTS

A correlation of .68 was found between the total IQ's yielded by the two tests. The hypothesis that the relationship between the total IQ's was not linear was rejected at the 5 per cent level of confidence.

The correlations of the primary ability IQ's with the Performance and Verbal IQ's are presented in Table 1. Space, Reasoning, and Verbal-meaning correlate more highly with the Verbal IQ than with the Performance IQ, while Number and Perception correlate more highly with the Performance IQ.

Calculations of the significance of the difference between the two correlations for each primary ability were made, using the formula taken from Johnson (1). The results are given in Table 2. Only the correlations

[2] Two examiners administered the tests to the children. Preliminary meetings and training sessions, plus provision for the use of combined judgment in scoring questionable items provided assurance that the techniques of administration and scoring of the tests were essentially the same for the two examiners.

for Verbal-meaning were found to be significantly different, with this difference significant at the 1 per cent level.

Means and standard deviations for each IQ secured are shown in Table 3. The group mean for the SRA total IQ is 3.3 points lower than the mean for the WISC, and the SRA scores have greater variance. All means, except SRA Number, are above average.

TABLE 2

F SCORE INDICATING THE SIGNIFICANCE OF THE DIFFERENCE FOR EACH PRIMARY ABILITY, BETWEEN ITS CORRELATION WITH THE WISC VERBAL IQ AND PERFORMANCE IQ

IQ	*F Score**
Space	.125
Number	2.708
Reasoning	.515
Perception	2.825
Verbal-meaning	13.260

* An *F* Score value of 4.03 is significant at the 5 per cent level, of 7.18 at the 1 per cent level.

DISCUSSION

A correlation of .68 between the total IQ's on the two tests indicates some degree of correspondence between them. But it does not allow a high degree of predictability from one test to another.

At the beginning of the study certain hypotheses were set up with respect to the relationships of the primary ability IQ's with the Performance and Verbal IQ's. These hypotheses can now be considered along with the relevant results secured.

1. *It is hypothesized that the SRA Verbal-meaning IQ (V) will be more closely related to the WISC Verbal IQ than to the WISC Performance IQ.*

The null form of this hypothesis has been rejected. The correlation between Verbal IQ (WISC) and the Verbal-meaning IQ is .68, and the correlation between Verbal-meaning IQ and the WISC Performance IQ is .40. The difference between these correlations is significant at less than the 1 per cent level.

2. *It is hypothesized that the SRA Perception IQ (P) will be more closely related to the WISC Performance IQ than to the WISC Verbal IQ.*

The direction of the correlation differences is as predicted, but the correlations do not differ significantly.

TABLE 3

MEAN IQ AND STANDARD DEVIATIONS FOR WISC AND SRA ON 50 CHILDREN

	M	*SD*
WISC		
Performance	110.2	12.3
Verbal	113.2	10.8
Total	113.0	10.8
SRA		
Space	117.8	21.2
Number	97.7	10.5
Reasoning	118.0	18.8
Perception	107.9	18.4
Verbal-meaning	116.8	14.6
Total	109.7	13.2

3. *It is hypothesized that the SRA Space IQ (S) will be more closely related to the WISC Performance IQ than to the WISC Verbal IQ.*

The difference between the correlations of .34 and .49, with the Performance IQ and the Verbal IQ respectively, is not in the predicted direction. The difference between the correlations is not significant at the 5 per cent level of confidence.

4. *It is hypothesized that Reasoning ability (R) probably is important for success in both verbal and performance items.*

R correlates substantially with both WISC IQ's. The difference between the correlations of .63 and .55 is not significant at the 5 per cent level.

5. *It is hypothesized that Number (N) will not correlate more highly with WISC V IQ than with WISC P IQ and the correlations with both WISC IQ's will be low ones.*

The difference between these correlations of .38 and .15 (Table 1) is not significant at the 5 per cent level; nor does the second of the two *r*'s reach significance, although the first is significant at slightly less than the 1 per cent level.

Why should Space correlate as highly with the Verbal IQ as it does with the Performance IQ? It is suggested that there may be some processes of verbal conceptualization which are utilized in solving the Space items. Perhaps the child verbalizes to himself concerning the relationships of the geometrical figures, and his success in doing the items may be related to the verbal facility with which he makes these conceptualizations.

Why is the mean for the Number test lower than the other means? Two relevant factors may provide the answer to this question.

1. Content of the Number test. This test consists of addition problems which become progressively more difficult. It has a high speed component.

2. Arithmetic training of the subjects. The arithmetic program of the school places no emphasis on speed. Children are trained in the logic and rationale behind the manipulation of numbers, and are encouraged to check their answers through the use of various devices not used in the original solution of the problem.

Examination of the data indicates that the lower-than-average scores made by these otherwise intellectually superior children were due mainly to the speed factor, and not to inaccuracy of computation. An average of 27.3 addition problems were attempted by each child out of a total of 52 problems, and the average number of errors was only 2.1.

Even if this group of subjects had been given traditional arithmetic training, it is questionable to the writer whether the results of the SRA Number test could be said to give an accurate appraisal of their number abilities. Certainly the ability to handle speedily simple quantitative problems of one type seems to be tested here. However, it is questionable whether the child's ability to do arithmetic reasoning and computation of a variety of numerical problems is tested. These skills are, in the writer's opinion, an integral part of the individual's total numerical ability. The questions raised can, of course, be answered empirically. At this point, however, in the absence of evidence that N is predictive of these other skills, it seems that the limitations of the Number test, in terms of what it does and does not include, should be clearly understood by those using the test to determine a child's numerical ability.

The results of this study are, of course, limited by the fact that a highly selected sample of children was used. In order to increase confidence in them, a larger number of children representing a broader sampling of relevant experimental variables should be tested.

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STUDIES IN INTOLERANCE OF AMBIGUITY: I. THE DECISION-LOCATION TEST WITH GRADE SCHOOL CHILDREN

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Intolerance of ambiguity has been defined as "the tendency to resort to black-white solutions, to arrive at premature closure as to valuative aspects, often at the neglect of reality. . . ." (4, p. 115). The individual who is intolerant of ambiguity tends to categorize phenomena rather than to order them in a continuum. There is a tendency to precipitate judgment, both in perception and cognition. The theoretical explanation is that this individual feels acutely insecure in ambiguous situations, and hence tends to structure ambiguity prematurely, or at least sooner than individuals more tolerant of ambiguity.

Intolerance of ambiguity has been suggested by Frenkel-Brunswik (4) as the key variable in the ethnocentric personality. Two recent experiments (1, 11) have found that ethnocentrism is positively related to measures of intolerance of ambiguity in college students.

Although the existence of ethnocentrism in children has been well-demonstrated, (see for example 12, 13) there are few studies which bear on its relationship to intolerance of ambiguity at the lower age levels. Frenkel-Brunswik (3) claims to have found it in ethnocentric children in an analysis of interview data. An ongoing study by B. R. McCandless and H. D. Holloway will attempt to relate two measures of ethnocentrism and two of intolerance of ambiguity in elementary school children. No other studies in the area are known to the writer.

The purpose of the pilot work to be reported here is to investigate the usefulness of two proposed measures of intolerance of ambiguity, and to determine their relationship, if any, to ethnocentrism in children at the grade school level.

THE TESTS

Three tests were used in the study, the two proposed measures of intolerance of ambiguity and an ethnocentrism scale. The latter (hereafter referred to as GHME) was devised by Gough, Harris, Martin and Edwards (5). It has twenty-four items which are similar to those commonly used in adult ethnocentrism scales. The child indicates agreement or disagreement with each statement; the ethnocentrism score is the number of agreements. The test-retest reliablity of the GHME is .81.

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One measure of intolerance of ambiguity was the Decision-Location test (the DLT).[2] This is an adaptation of the Incomplete Pictures sub-test of the Minnesota Preschool Scale (14); it consists of two series of twenty straight-line drawings. The first picture of the series is a single line, and more lines are cumulatively added in each subsequent picture of the series, terminating at the twentieth picture as a drawing of a simple object. The final drawings in the two series used here are a truck (DLT_1) and a shoe (DLT_2). No method of estimating reliablity for the DLT has been developed as yet.

The drawings were made into 2 x 2 slides for group presentation. The slides were shown in serial order for 15 seconds each. The subjects were instructed to respond to each slide on a response sheet, which consisted simply of a column of numbers from 1 to 15 with a space for the response next to each number. The response sheet number corresponded to the position of the slide in the series. The crucial aspects of the instructions are presented below:

> Just as soon as you think you know what the picture on the final slide will be, write the name of the object on your response sheet alongside the number corresponding to the slide number. Do this even if you are not quite sure what the object will be. If you have any idea whatsoever of what the completed object will be, write it down in the correct space. However, do not guess if you have no idea at all. In that case, write "Don't know" in the space alongside the number corresponding to the number of the picture. You may change your mind about what the completed picture will be at any time. But do not change anything you have already written.

Etzel (2) found that accurate perception of the final object occurs at about the fifteenth drawing. If the full series of twenty slides were presented, the subjects would become aware of the accurate perception point, and would withhold guesses until that point in the subsequent series. For this reason only the first fifteen drawings in each series were used in this study.

As a further check on any tendency to go back and change earlier responses, the response sheet was broken up in three sections each containing five response spaces. Each was collected in turn before going on to the next five.

The instructions are deliberately made ambiguous so that each subject is free to guess or not to guess according to individual perception. The instructions are, of course, objectively uniform for all subjects, but it is presumed that the child who is intolerant of ambiguity will interpret the equivocal instructions as a requirement to guess as soon, and as much as possible.

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[2] The Decision-Location Test was designed by Drs. Barbara C. Etzel, now at the Bureau of Juvenile Research, Columbus, Ohio, and Sidney Rosenblum, now at the Wayne County Training School, Northville, Michigan. It was originally used in Dr. Etzel's dissertation (2) as an individually administered test. It was revised for group presentation for this study, and for subsequent studies by Drs. Etzel and Rosenblum and the author.

This expectation is founded on the many demonstrations of the effect of need on perception and interpretation.

The score for intolerance of ambiguity is the number of responses other than "Don't know" made prior to the point of clear perception. Clear perception is defined as an unbroken succession of correct responses ranging from some earlier slide to the final slide. It is rare that clear perception occurs before the thirteenth slide, and it is more common to find a correct response only on the fifteenth slide, or not at all.

The second measure of intolerance of ambiguity was the misconceptions test, which consists of forty-two popular misconceptions concerning such subjects as personality, physiognomy, mental illness, hypnosis, and natural science. Twenty items were taken from Nixon's work (10), eight from Hancock (6) and seven from an earlier study by the author (7). The remaining seven are from various sources. Terminology was carefully checked for vocabulary burden in view of the educational level of the subjects. A number of items were revised somewhat in the interests of simplicity.

The subjects were required to choose from three alternatives—true, false, or don't know—for each misconception. The M scale score was the number of misconceptions checked as true. Estimated reliability by the Kuder-Richardson short formula is .70.

Procedure

The ethnocentrism scale (GHME), the misconceptions scale (M), and the first series of the Decision-Location test (DLT), the truck, were administered to a group of sixty-six girls at a community summer camp in Eastern Iowa during the summer of 1953. The ages of the group ranged from 8 to 13 years with a school grade range from the 4th to the 8th. The mean grade level was 5.5, the mean age was 10.23 years.

The mean GHME score for the group was 8.12, the mean M score was 16.25, and the mean DLT was 5.99. The prevalence per misconception was 39 per cent. However, due to the camp schedule, 19 subjects were absent for the administration of the second DLT series, the shoe. The results to be presented here will be based only on the 47 subjects who participated in all phases of the experiment.

Results

The average grade level of the 47 subjects was 5.49, and the average age was 10.11 years, both practically identical with the original group. The means for DLT_1, GHME, and M are also very close to the original means, as can be seen in Table 1. Table 1 also gives the mean DLT score. The DLT score for each subject is obtained by adding her scores for DLT_1 and DLT_2. The DLT score is a more predictive measure than either of the series individually, as will be seen later.

TABLE 1

MEANS, STANDARD DEVIATIONS, AND RANGES FOR THE TESTS

	DLT_1	DLT_2	DLT	GHME	M
Mean	5.60	2.79	8.38	8.21	15.96
Standard Deviation	3.32	2.96	5.74	3.89	5.59
Range	0—14	0—15	0—26	2—15	6—28

Despite the precautions which were taken in administration, the scores for DLT_2 are significantly lower than those for DLT_1. The reason for this decline is not immediately apparent. The correlation between DLT_1 and DLT_2 is .66, not as high as might be expected, but certainly suggestive. This correlation may be considered to be a rough index of reliability for the test.

Table 2 shows the intercorrelations between the GHME, M, DLT, and the component series taken individually.

The DLT correlates .39 with the GHME and .43 with the M scale. Both of these correlations are significant below the .01 level. The GHME and M are not significantly related, the correlation being .19. A multiple correlation coefficient predicting the DLT from the GHME and M is .538.

DLT_1 is related to M ($r = .38$) but not to the GHME ($r = .17$). However, DLT_2 correlates significantly with the GHME ($r = .41$), but not with the M scale ($r = .21$). It is possible that the discrepancy between the means of DLT_1 and DLT_2 may be involved in this peculiarity. It is hoped that further investigation will provide a clue.

It is obvious that DLT gives more satisfactory relationships than either of its component series. This is, perhaps, no more than would be normally expected from a pooling of data. Again, we anticipate that additional work with the DLT will be revealing.

TABLE 2

INTERCORRELATIONS BETWEEN THE TESTS

	DLT_1	DLT_2	GHME	M
DLT_1	—	.66*	.17	.38*
DLT_2		—	.41*	.21
DLT			.39*	.43*
GHME			—	.19
M				—

* Significant below the .01 level of confidence.

Discussion

According to Frenkel-Brunswik's (4) generally accepted formulation to the variable, it was expected that those children who were relatively intolerant of ambiguity would exhibit a premature perceptual closure which would manifest itself in a greater number of precipitate guess responses to the DLT. Insofar as the GHME is a test of ethnocentrism, this expectation is tentatively borne out by the significant relationship between the two measures.

In an earlier article (8) the author advances the hypothesis that intolerance of ambiguity was a causal factor in the belief in superstitions and similar misconceptions. A misconception ordinarily flourishes in the area of ambiguity. The condition in which accurate information is not easily available creates an atmosphere suitable for the dissemination of popular misinformation. A misconception comes under the heading of what Frenkel-Brunswik (4, p. 140) calls "premature reduction of ambiguous cognitive patterns to certainty."

It has been shown (9) that belief in mental hygiene myths is related to ethnocentrism in high school students. The present study indicates that belief in misconceptions in general is associated with perceptual intolerance of ambiguity, but not with ethnocentrism, in elementary school children. It was considered hypothetically that the intolerant-of-ambiguity factor of the ethnocentric child underlies the tendency to accept misbelief. However, the results do not bear out this point.

It is of particular interest that the perceptual measure of intolerance of ambiguity, the DLT, and the cognitive measure, the M scale, which are operationally far apart, are significantly related. Unlike the M scale, the DLT correlates significantly with ethnocentrism as measured in this study. This set of findings appears similar to O'Connor's results (11) in which cognitive intolerance of ambiguity and poor abstractive ability were related to ethnocentrism, but not to each other except in ethnocentric individuals. The relatively poor reliabilities of the tests, and the absence of further information concerning them preclude further analysis of the results at this point.

In general, we believe that the DLT and the M scale show promise as measures of intolerance of ambiguity. A series of experimental studies with the DLT and variations of it is being planned.

Summary

The present study concerned the development of two tests of intolerance of ambiguity, the Decision-Location Test and the Misconceptions scale, and an investigation of their relationship to each other and to ethnocentrism as measured by the Gough-Harris-Martin-Edwards Scale. The subjects were forty-seven girls of ages 8 to 12 with a mean grade level of 5.49.

The DLT was found to be significantly correlated with the M scale and the GHME. The M and GHME were not related. It is concluded that the DLT and M may be regarded as measures of intolerance of ambiguity, and that there are indications that intolerance of ambiguity and ethnocentrism are associated characteristics in elementary school children. Further work along these lines is being planned.

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SELF-IDENTIFICATION AMONG ADOLESCENT BOYS

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Many psychologists maintain that the child allies himself more closely with the physical aspects of his existence as represented by his body and its function than he does with the mental and emotional aspects because these latter are less accessible and tangible to him (6). Social relationships are carried out with the body, and as a social vehicle it becomes important in the judgments that are made about the total self. From the time of Hall's first writings, adolescent psychology texts have emphasized the upsurge of concern with the body and its adequacy at adolescence. Several investigators have pointed out that the strong, muscular type of physique is a social advantage among adolescent boys. Cabot (2) found "athletosomic" boys more ascendant, extroverted, creative and less socially introverted than those having "leptosomic" or "pyknic" physiques. He concludes that the physique regarded as "good" is a strong determinant in traits which are fundamentally social in their genesis and development. The California Adolescent Growth Studies have indicated that the late maturing boy is likely to suffer some degree of social isolation because of his lag in physical development (4, 5). The immature body of the late-maturing girl does not seem to ostracize her to the same extent.

In these studies the adult investigators make the judgment of whether a physique is "good" or "poor," it being assumed that the adolescent boys' judgment proceeds from the same base-line used by the adult. Those who have been interested in the "body image," or picture of the body which the adolescent is forming in this preoccupation with his corporeal self, believe this image is sharpened by evaluation in terms of what their peers regarded as a "good" physique.

PROBLEM AND METHOD

It might be expected that since the adolescent spends so much time looking at himself in the mirror he should recognize his likeness without difficulty. In response to a challenge by the investigator forty adolescent, ninth grade boys comprising one entire gym class in an urban junior high school agreed to test the contention of several vociferous members of their group that they could easily recognize photographs of their own physiques. Photographs were accordingly taken of the nude subjects, rear view only, under standard lighting conditions from a standard distance. Each subject

was presented all forty photographs laid out on a table in a predetermined order and asked to identify each photograph, one of which was his own. He was allowed as much time as he pleased to complete the identifications and allowed to manipulate the pictures in any way he wished to make comparisons. The photographs were presented first with the heads covered and then again with the head masks removed to allow total body configuration to be used in the identification. As each photograph was studied the subject rated the physique on a five point scale and stated briefly his reason for the rating. Identification and rating completed he was asked to review the pictures and choose the "best" and "poorest" of the physiques. "Best" and "poorest" were not defined, each subject being asked to use his own subjective criteria for the rating. In addition to this peer group rating, three adult judges rated the photographs according to the Bayley-Bayer scales (1) which take into account the factors of direction, degree, tempo, and amount of incongruity in the same organism in making the sexual differentiation.

A measure of each subject's social standing was obtained through a sociometric technique employing the following questions: 1. With whom would you like best to go to the movies? 2. With whom would you like least to go to the movies? 3. Whom would you like best to have for gym service? 4. Whom would you like least to have for gym service? 5. Whom would you like to have for your best friend? 6. Whom do you like the least in this group?

All of the subjects had been together in the same gym class for at least a year, thirty-five of them for three years, so they had had considerable opportunity to observe each other in a relatively unclothed state. The socioeconomic level of the neighborhood which this school taps is slightly above average but is more heterogeneous than many of the areas in this city. Though all class levels are represented, the skilled working class predominates, with few of the parents falling below that class in occupation. All subjects were native-born, white. Chronological ages ranged from fourteen years, two months to sixteen years, seven months with a mean chronological age of fifteen years (*SD* 6.1 mos.). IQs ranged from a low of 60 to a high of 135, mean 104.6 (*SD* 16.75) by Otis group test.

Results

The three adult judges were able to reach satisfactory agreement in rating the physiques according to the Bayley-Bayer scales. Two of the judges, who had gone over the system and discussed it together before making the ratings, found their judgments in exact agreement in all but three cases and in these three cases the differences were very slight. The third judge, who had had no discussion of the system and had to rely on merely reading the directions before rating, reached 75 per cent agreement with both the

other raters, differences again never being greater than placement in an adjacent category.

In spite of the reputed body preoccupation only 12 of the boys (30 per cent), were able to correctly identify themselves when the heads of the photographs were covered. Adding the head to the pool of identification cues raised the number of correct identifications to 15, (or 37.5 per cent). No better than chance relationship existed between the degree of conviction felt in making the identification of any picture and the correctness of the response. They were as often wrong when they felt "certain" as when they "kind of guessed."

No significant difference in mental age appeared between those who correctly identified themselves and those who did not, the mean MA for the successful group being 190.5 months (*SD* 20.2) and the mean MA for the unsuccessful group 190.4 (*SD* 11.3). Chronological age likewise failed to provide a significant factor in success or failure for the mean CA of 180.9 months (*SD* 9.1) of the successful group turned out not to be significantly different from the mean CA of 180.3 (*SD* 6.5) in the group of unsuccessful self-identifiers.

The boys who were able to correctly identify themselves were significantly better in their ability to identify others. This group of successful self-identifiers made a mean number of 31.6 correct identifications (*SD* 3.1) out of the total number of 80 possibilities, as compared with a mean rate of 24.3 (*SD* 1.8) for the group as a whole, a difference which is significant at the 1 per cent level of confidence. This group who correctly identified themselves were also more often correctly identified by others at a mean rate of 31.1 times out of 80 tries (*SD* 5.2), a difference again significant at the 1 per cent level.

Though the group of successful self-identifiers constituted 37.5 per cent of the total group they received only 25 per cent of all social mentions. They did, however, receive 53.7 per cent of the designations as "best" and "poorest" physiques. It would seem possible, then, that the higher rate of identification of themselves and identification by others might be due to physical characteristics which made them conspicuous. This interpretation fails to account for their greater efficiency in identifying others unless one speculates that their physical deviation from the average caused them to be more body conscious both with respect to themselves and with respect to others.

No correlation appeared between the number of times the individual received social mention, either positive or negative, and the number of times he was correctly identified in the group as a whole (Pearson r of .00), but the correlation between amount of favorable mention and rate of being correctly identified was significantly positive at the 5 per cent level (Pearson r .43±.15). Correlation of degree of social rejection and rate of identification was insignificant but in a negative direction (r —.15±.18). There may be a tendency for boys to be more aware of the total person, including the body

as part of that total, in the peers they view with favor socially whereas the boys who are socially rejected are so largely on the basis of certain antagonizing personality characteristics. At least, if physical repulsion is any part of the social rejection picture the "image" is not sufficiently impressive to facilitate identification.

In their choice of "best build" the boys appeared to be seeking both masculinity, as measured by the Bayley-Bayer ratings, and symmetry. Two of the four most frequently chosen "best" builds received hyper-masculine Bayley-Bayer ratings; one of these tied for first place while the others trailed at fourth because, as the comments indicated, his shoulders were "too narrow" and "too sloping." The other two "best" builds received masculine ratings on the B-B scale but the one which tied for first place, though merely "masculine," was lauded frequently for its "swell proportions." Comments about preferred physiques overwhelmingly paid tribute to muscle development, with "good muscles," "strong back" and "muscular arms and legs" being most frequently mentioned. The diatribe hurled at the scorned figure was in almost every case "too skinny," with these figures all receiving low masculinity or asexual ratings on the Bayley-Bayer scales. That the boys' concept of what constitutes an ideal masculine physique closely approximates the adult standard is confirmed by the fact that three adult, male judges also chose as "best" the two winning physiques chosen by the adolescent boys.

Though some support is given the contention that the boy with the better physique is socially favored in that the four boys receiving the highest number of favorable social mentions were all rated above average in physique by their peers, the evidence is not as strong as one might anticipate from the generalization to that effect which is frequently made. The four boys suffering the greatest amount of social rejection were all rated average by the group. The general trend of evidence in this investigation gives but feeble support to the "good physique wins social favor" generalization when it is made without regard for the composition of the group in which the social acceptance and rejection is taking place.[1] Jones and Bayley (5) report no consistent or marked differences between early and late maturing boys in prestige and social effects on the group when the group is all boys, but do find prestige differences in favor of the early maturing in mixed groups, especially in later years. In view of their findings, the absence of striking relationship in this group may be due to the homogeneity of the

[1] A case history, follow-up comment may be made anent the later careers of the subjects showing high physical visibility. Three years after completion of the study the two boys who had tied for "best build" had both dropped out of high school after the tenth grade while the subject voted "poorest build" by a wide margin was graduated valedictorian of his class and showed good social adjustment. The two having "best build" fit neatly into the findings of the Gluecks concerning the predominance of mesomorphic somatype among delinquents (3).

group with respect to sex and the fact that at ninth-grade level the group of boys finds themselves still so transitional with respect to sexual maturity that relative immaturity does not yet make for great conspicuousness, either in appearance or in physical performance.

Summary

Forty adolescent boys attempted identification of their own and classmates nude, rear view photographs. Only 37.5 per cent of the subjects were able to correctly identify themselves. Those who were successful in self-identification were also more successful in identifying others and were more frequently identified by others. The study lends but slight support to the generalization that the boy with the admired physique tends to be socially favored. Homogeneity with respect to sex and the age of the group may account for this finding. The most admired physique was that combining strong muscle definition with V-shape symmetry—the stereotype of the strongly "masculine" physique.

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A DISTINCTION BETWEEN SOCIAL ACCEPTANCE AND PRESTIGE AMONG ADOLESCENTS

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To reveal some of the social pressures which are exerted by an adolescent group on its members, relationships between peer group ratings on certain traits and measures of social acceptance have been found. The results have been interpreted frequently as indicating prestige factors among adolescents (2, 10, 13). But the terms social acceptance and prestige have different meanings. Social acceptance connotes intimate face-to-face contacts which are in some way satisfying. Prestige, on the other hand, indicates the possession of admired or respected characteristics. A trait may be associated with prestige but not with social acceptance. It was the purpose of this study to test the hypothesis that, among adolescents, ratings of social acceptance and ratings of prestige show different degrees of association with other trait ratings.

DEFINITION OF TERMS

Social acceptance has been identified with sociometric status and hence has been measured by the use of a variety of sociometric tests (3, 5, 10). It has also been measured by ratings yielding scores on an acceptance-rejection continuum (3, 14). For this study social acceptance was defined as the extent to which an individual's company is regarded as rewarding by others. It was measured by asking adolescents whom they liked or did not like to be with, whom they enjoyed or did not enjoy having around. This procedure was judged to offer a more general estimate of social acceptance.

Prestige is to be defined in terms of valued characteristics. Benoit-Smullyan (4) has described a person of high prestige as an object of admiration, an object of deference, an object of imitation, a source of suggestion, and a center of attraction. Both he and Hollingshead (7) have indicated that the sources of prestige depend upon the values held by a particular group.

Miller and Dollard (11) have delineated fairly clearly the concept of prestige in terms of imitation. Queener (12) has taken their definition

of a prestige model as the basis for defining prestige as "the function of being regarded as a source of cues for rewarding responses." Thus an adolescent has prestige if others regard him as one who will cue them as to what to wear to a dance in order that they might receive social approval for being appropriately dressed.

Prestige was defined in this study as the extent to which an individual is regarded by others as possessing valued attributes. Valued attributes are those which constitute cues to responses others perceive as rewarding. To assist in the formulation of statements by which adolescents could rate others, the term "respect" was judged to denote this valuation of attributes by adolescents. Prestige was therefore measured by asking adolescents whom they did or did not respect, whom they thought did or did not have "something worth-while." The results of this rating form, of course, are limited to those aspects of prestige of which adolescents are aware as suggested to them by the terms employed.

Social acceptance and prestige are clearly related among adolescents. The factors which make face-to-face social contacts satisfying include the elements of prestige if for no other reason than the operation of prestige contagion; it is rewarding to be in the company of a prestige person. Furthermore, social contacts themselves result in changes in the value systems underlying prestige. There is also the factor that a person's prestige may be derived from his ability to make social contacts rewarding.

On the other hand some distinction is possible between the two concepts. Being regarded as a source of rewards may increase social acceptance but not necessarily prestige. The boy who shows approval of others or whose actions are entertaining may be sought out because his company is enjoyed but these characteristics will heighten his prestige only to the extent that these attributes are valued. Many factors, prestige sources in the culture, determine this valuational process in addition to the social contacts themselves. This difference is well illustrated by a case reported by Alexander and Alexander (1). Among 27 fourth grade children, they found that Joe received the highest number of choices on three sociometric tests. But a clinical study revealed that "Joe's high number of choices is based on his docility, conformity, and willingness to implement the ideas and projects of others. . . . he provides an outlet for the aggression of others in that it satisfies him and the aggressor" (1, p. 211). This boy's company may have been rewarding to others but he probably had little prestige in the group.

On the other hand an individual who is a source of cues to rewarding responses, who possesses valued attributes, may not supply direct rewards in face-to-face contacts. He may, for example, be so critical of others that few enjoy his company although they hold him in high regard. The distinction made here is implied by Tryon (13) when she spoke of the confusion between friendship-belonging and status-belonging among adolescents. Queener (11) has similarly differentiated between love and respect.

Hypotheses of the Study

Although it was assumed that there would be considerable agreement between social acceptance and prestige as they were measured, it was hypothesized that social acceptance is more closely associated with peer group ratings on friendliness and sociability, number of times chosen as a friend, and number of times chosen as a classroom companion. These traits seemed more likely to be characteristic of those whose company is rewarding. Prestige was judged to be more closely related to ratings on school marks, effort in schoolwork, cooperation with teachers and interest in serious activities, and to the variables of intelligence and socio-economic status. These attributes are more likely to act as cues to rewarding responses than they are to make an individual's company rewarding. Adolescents probably have acquired such value systems from their elders.

Procedure

Guess-who ratings on twelve bi-polar traits were obtained for 443 members of the high tenth grade in a large suburban high school from ninety per cent of this class. Each rater was asked to nominate persons of his or her own sex for 24 statements. In addition, each person was asked to indicate his three best friends and his first three choices for a class-room companion. Although, to encourage unfavorable ratings, raters were asked not to sign their names, a coding system permitted the discarding of all self-mentions. The population for this study consisted of 165 boys and 188 girls who were mentioned on an average of three or more times per trait for each of the twelve traits and thus were fairly well known by the raters.

Ratings for the criterion of social acceptance were obtained from the two following guess-who statements where the first statement was assigned positive values and the second statement negative. Changes on the girls' form are indicated in parentheses. It will be noted that to assist the raters a distinction is made between social acceptance and respect.

> Here is someone whom you like to be with; you may respect him (her) or you may not respect him (her) but you do enjoy having him (her) around.
>
> Here is someone whom you don't like to be with; you may respect him (her) or you may not respect him (her) but you do not enjoy having him (her) around.

In similar fashion the ratings for the criterion of prestige were obtained from the following statements.

> Here is someone whom you respect a lot; you may enjoy having him (her) around or you may not but you do feel that he (she) has something worth-while.

> Here is someone whom you don't respect very much; you may enjoy having him (her) around or you may not but you don't feel that he (she) has very much that is worth-while.

The statements for the other traits of interest for this study were worded in a similar fashion. For purposes of brevity, they may be described by the following paired phrases where the first applies to the statement assigned positive values: gets high marks—gets low marks, tries in schoolwork—does not try in schoolwork, sociable ("a good mixer")—not sociable ("does not mix well"), friendly—unfriendly, cooperates with teachers—does not cooperate with teachers, interested in serious topics—not interested in serious topics. In the last item "serious topics" was defined for the raters as world events, books or ideas, music, art, and scientific subjects.

The ratings were first scored according to CEI methods (6) by simply taking the algebraic sum of the numbers of positive and negative mentions for each trait. The reliabilities of these ratings in terms of amount of agreement among the raters were obtained by dividing the raters at random into two groups. The correlations after correction between the two sets of scores for each trait ranged from .69 to .96 with a median of .85 for the boys and .88 for the girls. These coefficients for social acceptance ratings were .77 for the boys and .76 for the girls while the corresponding figures for prestige ratings were .77 and .87.

The CEI scores for traits which were judged to depend on how widely known by the rating group the individual was were normalized since the distributions tended to be leptokurtic. These normalized scores were used for this study. These traits were social acceptance, prestige, sociability, and friendliness. This change probably did not affect the reliabilities of the two criteria since the correlations between the two normalized traits, .68 and .73, were identical with the correlations obtained between the original sets of CEI scores. Although these correlations are fairly close to the reliability coefficients reported for these traits, the comparison is not entirely appropriate since these reliabilities were based on ratings from different groups of raters while the correlations between the two traits were based on the same group of raters. The criteria of social acceptance and prestige do show, however, a considerable degree of similarity.

The traits which were judged not to be dependent on how widely known the individual was by the rating groups, school marks, school effort, teacher cooperation, and seriousness, were scored according to a method presented elsewhere by the writer (8) in which the CEI scores were weighted inversely according to a measure of how widely known the individual was by the rating group. In support of this procedure, it may be noted that on the traits teacher cooperation and school marks, higher validity coefficients were obtained for the weighted scores than for the CEI scores although the reliabilities were somewhat lower (9). The distributions for these weighted scores were all approximately normal.

The intelligence test scores were obtained with a few exceptions from the Otis Group test. The mean I.Q. for the boys and girls in this population was 104 with a standard deviation of 13. Occupation of father, scored on a scale from 1 to 7 by Warner at al. (15), showed a mean of 3.8 with a standard deviation of 1.4 for the members of this group for whom such data were obtained.

TABLE 1

COEFFICIENTS OF CORRELATION BETWEEN RATINGS ON SEVERAL PERSONALITY TRAITS AND TWO CRITERIA (SOCIAL ACCEPTANCE AND PRESTIGE) AND THE DIFFERENCES BETWEEN THEM FOR BOYS AND GIRLS

(based on a population of 165 boys and 188 girls in the high tenth grade)

Trait	*Sex*	Correlation with *Social Acceptance*	Correlation with *Prestige*	*Difference Between Corresponding r's*
Friendliness	Boys	.60	.61	.02
	Girls	.62	.59	.05
Sociability	Boys	.50	.50	.00
	Girls	.53	.43	.13*
Times chosen as Friend	Boys	.63	.47	.23**
	Girls	.53	.44	.12*
Times chosen as Classroom Companion	Boys	.52	.42	.12
	Girls	.55	.43	.16**
School Marks	Boys	.37	.58	.27**
	Girls	.39	.63	.32**
Effort in Schoolwork	Boys	.41	.55	.18**
	Girls	.46	.69	.35**
Cooperation with Teachers	Boys	.40	.60	.27**
	Girls	.54	.74	.35**
Serious Interests	Boys	.08	.33	.26**
	Girls	.02	.26	.25**
Intelligence†	Boys	.22	.20	.02
	Girls	.14	.22	.08
Occupation of Father‡	Boys	.11	.21	.10
	Girls	.09	.19	.10

† Based on populations of 160 boys and 178 girls.

‡ Based on populations of 134 boys and 162 girls. Warner's scale was reversed so that high scores mean high occupational level.

* Differences significant at .05 level. The values of the standard error of the difference ranged from .05 to .08. These were computed by including the correlational term, $r_{rr'}$, whose values ranged from .54 to .73.

** Differences significant at .01 level. See previous footnote.

Results

The correlations between each of the criteria of social acceptance and prestige with each of the other variables in this study are indicated in Table 1. The significance of the difference between the two correlations was computed for each variable by taking into consideration the fact that these correlations were themselves correlated. For the traits friendliness and sociability the differences were slight and inconsistent although sociability for the girls was more closely related to social acceptance than to prestige at the .05 level. The sociometric type questions produced results which were more closely associated with social acceptance in each case but on only two of the four comparisons were the differences significant at the .01 level with another significant at the .05 level.

All comparisons with respect to school marks, effort in schoolwork, cooperation with teachers and serious interests, showed that these variables were related significantly more closely to prestige than to social acceptance. No large differences were found on comparisons regarding intelligence or father's occupation for this population, all these correlations being fairly low.

Discussion and Conclusions

It should be noted first that the criteria, social acceptance and prestige, are closely related. The correlations between them, .68 for the boys and .73 for the girls, are high for trait ratings of this type, and as a consequence the patterns of association with other variables are quite similar. But the fact that significant differences were found indicates that the two concepts, at least as measured by these ratings, are not synonymous.

While social acceptance was more closely related than prestige to all four measures obtained from sociometric type questions, in two of the comparisons the differences were not significant at the .01 level. Since we would expect fairly high agreement, this requires an explanation. The correlations between social acceptance and numbers of times chosen were not high. Ausubel, Schiff, and Gasser (2) with comparable measures found slightly lower coefficients than those here reported. This is attributable to the fact that rejections were not included for these sociometric type questions as they were for the criteria. An individual may be chosen as a friend or companion by many individuals but he may be rejected by even more. If such rejections had been included in the scoring of these questions, the correlations with both of the criteria would have been higher and the differences between them probably would have been larger.

Another factor in these findings is that, particularly for the girls, the measure of prestige probably was more reliable; this would have produced relatively higher correlations for this criterion. A third possible factor is that the more intelligent and more academically successful students may have made more nominations for the guess-who statements and hence

were more influential in determining these scores. For the sociometric questions each rater contributed only three nominations, thus providing a more equal weighting for the different groups within the population.

The fact that no large differences were found for friendliness and sociability would suggest that these traits are valued comparatively highly by this population. It should be noted that the raters were asked who was friendly toward or sociable with people in general. Many raters probably nominated persons with whom they had little social contact. Undoubtedly different results would have been obtained if the questions had been worded differently, for example, "Here is someone who is friendly toward you." Raters would have been more likely to nominate those persons whose company was rewarding.

It seems fairly clear that the traits, school marks, effort in schoolwork, cooperation with teachers, and serious interests, are all related to prestige more than to social acceptability. While in the case of the girls particularly the greater reliability of the measure of prestige might have accentuated these differences, the distinction seems quite tenable. The fact that the ratings were obtained in a school situation may have operated to influence the raters' nominations in this direction. But it should be noted that the raters were not asked what attributes they valued; to have done this might more easily have elicited the responses which they felt the school expected of them. The method used in this study for obtaining this information reduced such halo effect and the results probably apply to these adolescents during school-related activities. Somewhat different findings might be obtained if the study were conducted in a city playground or among organizations not connected with the school.

These results cannot be interpreted as representing the value systems of all segments of this population. For example, as Anastasi and Miller (2) have pointed out, differences between those preparing for college and those with no such plans probably exist. It would appear, however, that home, school and community have succeeded in developing certain (middle class?) value systems among a large proportion of these high school pupils.

The fact that the correlations of the criteria with intelligence were low and did not differ significantly would suggest that it is demonstrated ability, for example, in the form of school achievement, which is involved in prestige rather than the kind of potential indicated by intelligence tests. But it is possible that these low relationships resulted from the fact that adolescents with high and low intelligence seldom mentioned each other for either the negative or positive statements of the criteria. An analogous situation may have acted to produce the fairly low correlations obtained for prestige with occupation of father. While the possibility exists that in this urban school a cosmopolitan spirit has been created where little attention is given to the individual's family status, the findings might mean the opposite; adolescents from different class levels may be so far removed that lack of acquaintance

prevented their nominating each other for many statements on the guess-who device used in this study.

The distinction between social acceptance and prestige may be an important one. Tryon has pointed out that many adolescents choose companions or friends entirely on the basis of prestige. She suggests that in such situations an individual may be deprived of meeting certain affectional needs which during adolescence must be met in part by his age-mates. In analyzing the nature of the rewards obtained in a friendship, the most desirable situation may be found where one child's prestige for the other is neither excessively strong nor comparatively weak. On the other hand to discover the prestige sources among an adolescent population we may be in error in identifying the individuals with highest social acceptance. It seems probable that for some areas of influence, e.g. behavior at a high school dance, social acceptance may be identified with prestige but for other areas, e.g. behavior in the classroom, a clear distinction may be needed.

Summary

A theoretical distinction was made between social acceptance and prestige by offering different definitions for these terms. The hypothesis that these two traits, as measured by peer group ratings, show different degrees of association with ratings on other traits was tested with tenth grade subjects. While social acceptance was more closely associated with number of times chosen on two sociometric type questions which did not include rejections as did the criteria, two of the four differences were significant at the .01 level and a third at the .05 level. Prestige was significantly more closely associated at the .01 level for each comparison with school marks, trying in school, cooperation with teachers, and serious interests, all of these variables being determined from peer group ratings. Certain implications of the findings were made.

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A NOTE ON JUVENILE DELINQUENTS AND THE ABILITY TO ABSTRACT

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In the course of several years experience with male juvenile delinquents, the authors were impressed with the fact that many delinquents knowing that a certain type of behavior was inappropriate or wrong in a given situation did not seem to recognize that this behavior was inappropriate also in another situation which differed somewhat from the given situation. Stated another way, they did not seem able to recognize that situation X, although somewhat different from situation Y, belonged to the same class of situations as Y, P, Q, etc., and that the same rules of behavior applied to each of these somewhat different situations.

The ability to recognize a situation as belonging to a certain class and to regulate behavior accordingly obviously involves a motivational factor, but might it not also involve a basic factor which might be termed "abstract thinking"?

In regard to their findings on the generalizations made by delinquents and non-delinquents, the Gluecks (1) came to this conclusion: "The delinquents apparently do not accumulate a large repertoire of symbols (Vocabulary test) or of symbolized content (Information test). Their generalizations are closely, even though not directly, geared to concrete entities."

Because of this inference regarding the abstracting ability of delinquents, an attempt was made to ascertain whether there was any significant difference between delinquent and non-delinquent males of comparable age and intelligence in the ability to abstract the general principles from proverbs.

SUBJECTS

Thirty-three male high-school students and twenty-nine delinquent boys from Boys Vocational School, Lansing, Michigan served as subjects; they were equated for age and intelligence.

PROCEDURE AND RESULTS

A list of ten proverbs was drawn up and presented in mimeographed form. Both groups were told that this was an attempt to find out something about the way people think. Following this procedure a group intelligence

test was administered. Next, the proverb sheets were distributed and the subjects were asked to explain, in writing, what each proverb meant.

A rating scale was devised by means of which one of six scores was assigned to each proverb-interpretation for each subject. The scores ranged from zero to three. A subject's score consisted of the total number of points earned. Four psychologists served as independent raters. The correlation coefficients between raters ranged from .88 to .97.

Using one rater as a standard, the ratings of all judges were transformed into comparable scores. When means and standard deviations of the groups had been obtained, the *t*-test was applied to determine the significance of the difference between delinquent and non-delinquent groups. The results indicated that there was no significant difference between the groups in their ability to abstract the general principle from proverbs.

Discussion

The findings in this study do not support the hypothesis of a relative inability on the part of delinquents to engage in abstract thinking as this ability may be measured by the interpretation of proverbs. These findings appear to be in conflict with those of the Gluecks (1).

Further efforts to investigate the importance of this factor of abstracting ability in delinquents should probably utilize a wider variety of techniques before definite conclusions are drawn.

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MOTOR PERFORMANCE OF CEREBRAL PALSIED CHILDREN AS A FUNCTION OF THEIR SUCCESS OR FAILURE IN ACHIEVING MATERIAL REWARDS [1]

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The successful physical and occupational rehabilitation of cerebral palsied children is dependent primarily upon the efficient learning of motor skills. A mastery of motor fundamentals (i.e., pre-functional activities) and the acquisition of complex, integrated motor patterns (e.g., eating, dressing, washing, etc.) often represent important therapeutic goals.

The development of such motor skills is influenced, to a large extent, by the child's interests and attitudes toward treatment. The importance of motivational variables is reflected, too, in the fact that long and arduous retraining procedures in which the handicapped child participates tend often to produce discouragement and a consequent lack of effort toward attaining treatment goals. Even prior to the inception of therapy, it frequently has been observed that many chronically handicapped children lack the drive and interest which are necessary for learning self-help activities. These observations emphasize the importance of understanding the influence of motivational factors on the motor performance of the cerebral palsied child.

The present study sought to determine the effect of success and failure in securing material rewards on the cerebral palsied child's speed of performance of a pre-functional activity similar to those taught in the hospital's occupational therapy department. It was decided to use material rewards because such incentives had been found by other investigators to be successful in improving the verbal and motor behavior of non-handicapped children.

Certain fairly consistent findings from these previous studies are as follows:

1. The greater effectiveness of reward and reproof in facilitating performance as contrasted with non-incentive conditions (1, 2, 3, 5, 6).

2. The gradual decline in the effectiveness of repetitive, standardized verbal rewards (1).

3. The improvement in performance when a material reward follows a period of either verbal or no reward as opposed to a decrement in per-

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formance when there is a change from a material reward to a non-reward condition (1).

4. The facilitation of performance through the mere presence of material rewards, without regard to the subject's success or failure in achieving them during training (1, 2, 3).

The present experiment was designed as a means not only of demonstrating the effectiveness of material rewards in improving motor performance, but also of testing the commonly-held belief that chronically handicapped children often show less adequate behavior in frustrating situations than they do under non-frustrating circumstances. The experimental conditions of success and induced failure(i.e., frustration) made possible a study of the handicapped child's assumed differential reactions in stressful and non-stressful situations.

Experimental Procedure

Subjects

Twenty-five children who were in residence at the North Carolina Cerebral Palsy Hospital were used in the study. Each subject was assigned to one of five test groups: Neutral ($N = 4$); Success-Reward ($N = 6$); Failure-Reward ($N = 6$); Prolonged Success-Reward ($N = 4$); Prolonged Failure-Reward ($N = 5$).

Initially, the subjects were assigned to these groups on the basis of approximate matching for age, intelligence, physical diagnosis, severity of handicap, cooperativeness (as rated by hospital personnel) and initial test performance. As the experiment progressed, however, the lack of subjects available for experimentation made it impossible to adhere to such rigorous matching procedures. However, an attempt was made to keep all five groups reasonably equivalent with respect to these variables.

The children ranged in age from 6 to 12 years. Both boys ($N=12$) and girls ($N = 13$) were selected, since performance on the motor task which was used did not appear to be a function of sex differences. All subjects were of borderline intelligence or above, except for three children who had IQ's in the sixties. These three children, however, were able to perform the task satisfactorily. Each child's intellectual level was defined by the highest Stanford-Binet (1937 revision—Forms L and M) score obtained during his stay in the hospital, since some children were re-tested one or more times. Since the severity of physical handicap of many of the children influenced their performance on intelligence tests, these obtained IQ's were regarded only as approximations of intellectual levels.

Eighteen of the subjects were spastics and seven were athetoids. All of the children had involvement of at least one of the upper extremities. Some subjects had additional involvements of speech and lower extremities, but, since the experimental task involved the use of only one of the upper ex-

tremities, it was believed that this additional handicap would not seriously impair test performance. This was confirmed by observations made in the experimental setting. Although the extent of physical handicap varied, all children met the minimum requirement of having evidenced success in carrying out various self-help activities in the hospital.

Ratings for cooperativeness and adjustment to hospital routine were obtained from therapists' progress notes in the medical folder. Only those children who were reasonably cooperative in participating in the hospital routine were selected for the study.

None of the children tested had had previous experience with the task, although the movements that were involved were somewhat similar to other types of activities taught in the occupational therapy department.

Apparatus

The motor task involved the placing of large wooden cylindrical pegs into a wooden pegboard containing 28 holes. The subject, who was seated at a low table on which the pegboard rested, used his dominant hand to withdraw one peg at a time from a supply in a wooden trough which was placed beside the pegboard.

During the experimental conditions of success and failure, a miniature "community fund" type of scoreboard, which was mounted on an easel, was placed before the subject. This scoreboard contained three identical grooves into which were inserted red masonite strips, each of which could be raised to indicate improvement in the subject's performance. The three grooves were used to represent pictorially the subject's performance on a three-day block of trials. In addition, a miniature Hershey bar, which served as the material reward, was attached to the scoreboard at a specified height above the red marker. Speed of performance was measured with a stop watch.

Procedures

The subject was required to fill all holes of the pegboard for each trial. Four trials daily, spaced one minute apart, were administered for fifteen days with a one-day lapse following both the 6th and 12th day. As can be seen in Table 1, which summarizes the experimental design, five different groups of subjects were used. 1. The Neutral Group (N), which served as a control group, received only verbal praise throughout the fifteen days. 2. The Success-Reward Group (SR) received verbal praise plus the successful attainment of candy rewards. 3. A Failure-Reward Group (FR) was distinguished by verbal reproof accompanied by failure to win the candy reward. These SR and FR subjects were trained under "neutral" conditions for days 1-3, 7-9, and 13-15 and under "success" or "failure" conditions respectively for days 4–6 and 10–12. 4. Prolonged Success-Reward (PSR) and 5. Prolonged Failure-Reward (PFR) Groups were

TABLE 1

THE EXPERIMENTAL DESIGN

		CONDITIONS				
Days	*Block*	*Neutral* N	*Success-Reward* SR	*Failure-Reward* FR	*Prolonged Success-Reward* PSR	*Prolonged Failure-Reward* PFR
1– 3	1	Neutral	Neutral	Neutral	Neutral	Neutral
4– 6	2	Neutral	Success-Reward	Failure-Reward	Success-Reward	Failure-Reward
7– 9	3	Neutral	Neutral	Neutral	Success-Reward	Failure-Reward
10–12	4	Neutral	Success-Reward	Failure-Reward	Success-Reward	Failure-Reward
13–15	5	Neutral	Neutral	Neutral	Neutral	Neutral

tested under the same procedures as the SR and FR groups but their "success" and "failure" conditions extended throughout days 4–12. The response measure employed was the time required to fill all 28 holes of the pegboard. Observations of the subjects' behavior during the test trials were recorded by E.

The instructions to the subjects, which were the same for all groups under all conditions, emphasized speed of performance. At the beginning of each trial, the subject was urged to work more rapidly than on previous trials.

Under the Neutral conditions, E's statements at the conclusion of each trial were somewhat similar to the expressions of verbal praise used by the hospital's occupational and physical therapists during treatment. These statements (e.g., "that was fine," "you did well," etc.), although varying slightly from trial to trial, were identical for all subjects.

With the introduction of the "success" and "failure" conditions, the subject was told that the quality of his performance would be recorded on the scoreboard, with increased speed reflected by an upward movement of the red marker. The subject was informed that if he succeeded in making the marker reach the chocolate placed on the scoreboard, he would win the candy.

For the SR and PSR groups, the scoreboard was manipulated to permit the subject to win these candy rewards at the conclusion of each day's trials. In addition, following all trials, standard statements of verbal praise were employed by the experimenter.

Under the FR and PFR conditions, the marker of the scoreboard was moved only minimally in order to prevent the subject from winning the candy. Standard statements of verbal reproof also followed all trials (e.g., "That was pretty slow," "That was so poor that the marker doesn't move at all.").

TABLE 2

GROUP MEANS (RAW TIME SCORES AND CORRESPONDING PERCENTAGE SCORES) AND SIGMAS FOR SUCCESSIVE BLOCKS OF TRIALS

Raw Scores in Seconds — All Groups

	N		SR		FR		PSR		PFR	
Blocks	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*
1	99.40	28.63	118.78	40.55	78.95	18.43	102.80	45.10	68.54	23.58
2	92.65	26.23	96.67	33.20	61.07	13.12	85.00	32.98	56.32	17.36
3	96.00	30.57	101.65	30.68	67.75	17.13	86.55	37.15	58.20	18.84
4	95.15	32.42	94.78	30.73	61.16	13.33	92.13	45.95	58.20	20.20
5	87.25	23.16	101.65	30.68	65.17	14.70	92.38	43.55	63.42	22.74

Percentage Scores — All Groups (Block 1 = 100%)

	N		SR		FR		PSR		PFR	
Blocks	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*
1	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
2	93.63	4.35	81.78	8.70	77.74	2.20	84.54	5.22	83.59	5.96
3	96.09	6.14	94.47	12.82	85.54	4.69	85.24	7.23	85.91	4.90
4	94.47	6.75	80.38	11.22	78.04	5.58	88.67	8.98	85.30	4.88
5	88.53	3.00	87.75	13.60	82.86	5.93	89.63	8.30	92.55	7.04

RESULTS

The statistical analysis was based upon the mean time of performance for the various groups under the five test conditions. These means were derived as follows: (*a*) Means of the time scores for individual subjects were computed for each successive block of trials (e.g., Block 1 represented the mean time for all 12 trials administered during days 1-3; the Block 2 mean was based on trials for days 4-6, etc.); (*b*) These means were converted into percentage scores represented by the ratio[2] of the mean value for each block divided by the mean value for Block 1, which was assigned a base value of 100 per cent. These conversions were necessary because variations in physical handicap produced marked differences in the response times for trials during Block 1 (the initial neutral condition for all sub-

[2] It was observed that those children who initially performed the task most slowly also tended to show the greatest improvement in performance as the trials progressed. Hence, it was decided to use ratios rather than difference scores in order to make more equivalent the contributions of the initially slow and initially rapid children to the derived averages.

jects). (*c*) The group means for each block were then computed from the individual subject means which had been derived in (*b*) above.

The two sets of group means (actual time scores and corresponding percentage scores) and their sigmas for successive blocks of trials are presented in Table 2. The mean percentage scores for all groups are plotted graphically in Figure 1. The curves for individual subjects, similarly based upon percentage scores, are presented in Figure 2.

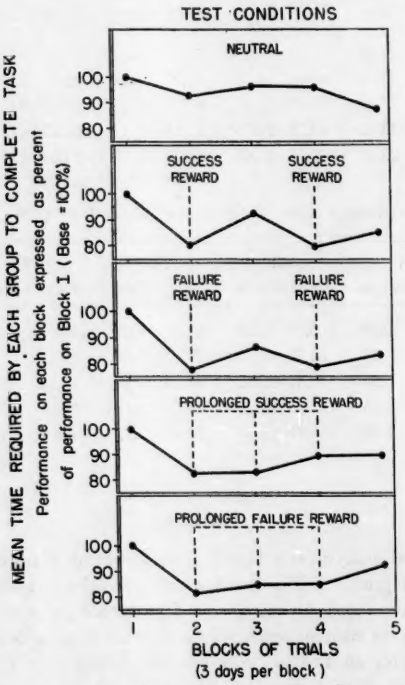

FIGURE 1

Examination of Figure 1 suggests that the shape of the N group curve[3] differs from the shapes of the curves for all four experimental conditions. There is, however, a striking similarity in the shapes of the SR and FR

[3] Figure 2 suggests that the downward slope of the N curve for Block 5 has been influenced largely by subject S4. The recent addition of three other subjects to the neutral group has resulted in an even more markedly flattened N group curve with little improvement in performance evidenced from Blocks 1-5.

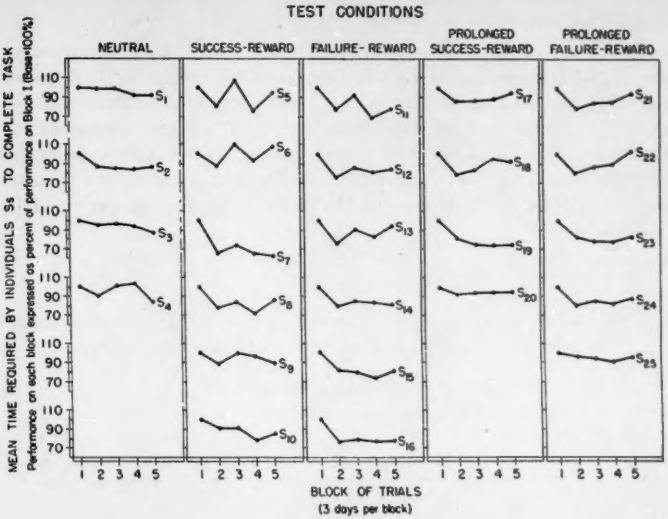

FIGURE 2

curves. The PSR and PFR curves also appear markedly similar. These suggested similarities in performance between the various groups were tested by over-all group, inter-group and intra-group comparisons as described below.

Over-all Group Comparisons

As a preliminary step a simple analysis of variance[4] was used to test whether the means (using converted scores) of all neutral trials for all five groups differed significantly from each other. This analysis yielded an F ratio of 1.12 which, for 4 and 20 *d.f.*, did not permit rejection of the Null hypothesis. Similarly, an analysis of variance of the means for all incentive trials (both success and failure) for the four experimental groups also indicated that there were no significant differences between the groups ($F = 1.44$; 3 and 17 *d.f.*).

Two conclusions were suggested by these results: (*a*) Any modification in performance which may have occurred under the incentive conditions apparently failed to transfer significantly to subsequent neutral trials. (*b*) The "success" and "failure" conditions used in this experiment apparently were equally effective incentives in modifying motor performance. These conclusions were further tested by inter-group and intra-group comparisons.

[4] Tests of homogeneity of variance for the group means of the incentive trials as well as the neutral trials did not permit rejection of the Null hypothesis.

Inter-Group Comparisons

Two types of inter-group comparisons were made. Each experimental group was compared with all other experimental groups with regard to the mean performance for all blocks of trials tested under incentive conditions. In addition each of these mean scores for incentive conditions for each experimental group was compared with the mean performance of the Neutral group on parallel blocks of trials. The means and sigmas (percentage values) for these comparable blocks for all groups are presented in Table 2.

TABLE 3

MEANS (PERCENTAGE SCORES) AND SIGMAS FOR COMBINED INCENTIVE AND NON-INCENTIVE BLOCKS OF TRIALS FOR ALL GROUPS

Non-Incentive Blocks

Combined Blocks	N		SR		FR		PSR		PFR	
	Mean	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*
1,2,3,4,5	94.55	3.06								
1,3,5	94.37	2.37	94.07	8.62	89.46	2.99				
1,5	94.27	1.50					94.82	4.16	96.28	3.52

Incentive Blocks

Combined Blocks	N*		SR		FR		PSR		PFR	
	Mean	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*	*Mean*	*Sigma*
2,4	94.1	4.35	81.1	9.50	77.9	2.91				
2,3,4	94.7	4.94					86.2	6.34	84.9	4.58

* Represents non-incentive blocks of trials of the control group which are temporally equivalent to the incentive blocks of the experimental groups.

The results of *t*-tests (unrelated measures) for significance of differences between these various group means are tabulated in Table 3. They may be summarized as follows: (*a*) The performance of the SR, FR, and PFR groups under material incentive conditions was significantly superior to the performance of the N group (under temporally equivalent trials) tested under verbal praise alone. Although the mean score of the PSR group was superior to that of the N group, this difference merely approached significance. (*b*) With the exception of the superiority of the FR group to the PFR group, there were no significant differences among the experimental groups in their motor performance during trials in which "success" or

"failure" in achieving material rewards was operative. (*c*) There was a slight, although non-significant, tendency for superior group performance under "failure" conditions as compared with "success" conditions.

Intra-Group Comparisons

To ascertain whether subjects in each of the experimental groups showed an improvement on incentive trials relative to their performance under the neutral trials, *t*-tests (related measures) for the significance of differences between the means of the incentive and non-incentive blocks were done for all four experimental groups. To test whether similar changes occurred in the Neutral group, *t*-tests were also made comparing the mean performance of the N group on equivalent blocks of trials. The mean and sigma values (in percentage scores) for these comparable blocks of trials for all groups are presented in Table 2.

TABLE 4

TABLE OF INTER-GROUP *t*-TESTS: SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS (INDEPENDENT MEASURES) OF INCENTIVE AND NON-INCENTIVE BLOCKS OF TRIALS

Groups and Blocks Compared	*t*	*df*	*Level of Significance*
N (2,4) *vs.* SR (2,4)	2.64	8	$<.05$
N (2,4) *vs.* FR (2,4)	5.72	8	$<.01$
N (2,3,4) *vs.* PSR (2,3,4)	1.83	6	NS ($<.20$)
N (2,3,4) *vs.* PFR (2,3,4)	2.68	7	$<.05$
SR (2,4) *vs.* FR (2,4)	.72	10	NS
SR (2,4) *vs.* PSR (2,3,4)	.91	8	NS
SR (2,4) *vs.* PFR (2,3,4)	.79	9	NS
FR (2,4) *vs.* PSR (2,3,4)	2.14	8	NS ($<.10$)
FR (2,4) *vs.* PFR (2,3,4)	2.67	9	$<.05$
PSR (2,3,4) *vs.* PFR (2,3,4)	.30	7	NS

The results of these *t*-tests, which are summarized in Table 4, indicate the following: (*a*) The SR, FR, and PFR groups showed a significant improvement in performance under the incentive conditions as contrasted with the non-incentive conditions. For the PSR group, which also showed improvement, these differences merely approach significance ($p<.1$). (*b*) The N group, however, failed to show any comparable improvement. Thus, both "success" and "failure" in achieving material rewards were effective in markedly improving the motor performance of these cerebral palsied children, whereas the invariant use of verbal praise failed to do so.

The upward trend of the PSR and PFR curves over Blocks 2 to 4 suggested that, as these incentive conditions continued, the material rewards may have gradually lost their reinforcement value. To test this hypothesis, the mean scores for each group on blocks 2 and 4 were compared to see whether performance on the latter trials was significantly slower. The results of *t*-tests (related measures), however, indicated that there were no significant changes in performance over these trials for either the PFR or the PSR groups.

TABLE 5

TABLE OF INTRA-GROUP *t*-TESTS: SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS (RELATED MEASURES) OF INCENTIVE AND NON-INCENTIVE BLOCKS OF TRIALS

Blocks Compared	*t*	*df*	*Level of Significance*
N (1,3,5) *vs.* N (2,4)	.58	3	NS
SR (1,3,5) *vs.* SR (2,4)	5.05	5	$< .01$
FR (1,3,5) *vs.* FR (2,4)	6.96	5	$< .01$
PSR (1,5) *vs.* PSR (2,3,4)	2.48	3	NS ($< .10$)
PFR (1,5) *vs.* PFR (2,3,4)	6.00	4	$< .01$

DISCUSSION

The results clearly indicated that the invariant use of verbal praise, similar to the type usually employed by physical and occupational therapists during treatment, had little effect in modifying the motor behavior of cerebral palsied children. The introduction of material incentives, however, markedly improved their performance of a simple motor task. It was apparent from examination of the curves of all experimental groups that the increments in performance during incentive trials were a function of the mere presence of the material incentives rather than of success or failure in achieving them.

Examination of Table 2 suggests that the FR condition was most effective both in improving performance during the incentive blocks and in transferring such effects to the subsequent neutral trials. Thus, the FR group performed better than all other groups on the final block of neutral trials (block 5). In addition the PFR group performed as effectively as the PSR group on the pegboard task.

On the basis of these results, it becomes difficult to accept any generalized assumption that handicapped children adapt less adequately to frustrating situations than to non-frustrating experiences. The children tested under the FR and PFR conditions were subjected to marked frustration since, in many

instances, these subjects were tested concurrently with other children who were being run under "success" conditions.[5]

It became known among the children of the hospital that, while the "failure" subjects were unable to achieve the candy prizes, other ("success") children, who were being tested at a different time during the same day, were successful in gaining these rewards. Nevertheless, the members of the "failure" groups, through their verbal statements to E, continued to manifest a dogged determination to improve in the hope of securing the material incentives. Unlike any of the children in the other groups, these subjects verbally expressed aggression and hostility. Some expressed preference or affection for another psychologist who had not participated in the experiment, while others expressed a dislike of the experimenter or made semi-serious threatening gestures toward him. Such behavior, however, was not excessive nor did it interfere with the subjects' efficiency in performing the motor task.

It was not possible to differentiate the frustration responses of our subjects on the basis of type of cerebral palsy. This finding is of interest in view of Phelps' (7) contention that the reactions to frustration of the athetoid differ significantly from those of the spastic and ataxic. Dr. Phelps has stated that the athetoid tends to be more markedly aggressive following frustration, whereas the spastic child responds in a more stoical fashion. The present findings do not suggest a differential responsiveness to frustration based upon type of cerebral palsy.[6] In view of the small number of subjects used in the experiment, however, it is not possible to draw any extensive generalizations regarding the cerebral palsied child's behavior under frustration.

A consideration of the experimental design is necessary to examine the marked effect of the incentive conditions on the performance of the simple motor task employed in this study. The experiment set out to determine the effect of motivational factors on the motor behavior of cerebral palsied children. It was designed with a view to minimizing insofar as possible, the one most important irrelevant variable, the learning factor, which, in the opinion of some present-day theorists (4), is definable in terms of "habit strength." The literature of recent years on motivation and learning in the realm of animal experimentation has made it clear that performance at a given time is a function of the momentary state of motivation and of the strength of the habit which is under consideration. For a task which is easy to learn, and with motivation held constant, the curve of performance

[5] In order to eliminate the introduction of a possible frustrating factor in the test situation, children of the N group were never tested concurrently with children of the incentive groups.

[6] These findings, however, have led to a more specific investigation of Dr. Phelps' contentions. The data, which will be published in a forthcoming paper, failed to support most of his hypotheses.

reaches an asymptote after but a few repetitions of the task. The curve of performance for a more difficult task reaches an asymptote more slowly.

Examination of the curves for the individual subjects in the N group indicated that an asymptote in the curve of daily performance (not presented) was reached by the 8th to 10th trials (2nd or 3rd days). Since the "habit strength" apparently approached its maximum during the Block 1 trials, it seems clear that the performance on subsequent blocks of trials was being modified by the incentive conditions rather than by learning factors. This heightens the importance of the improvement which followed the introduction of incentive conditions, since far less behavioral variation would have been expected after an asymptote in the performance curve had presumably been reached.

This attempted separation of motivational factors from learning factors, however, restricts the generalizations that can be made about the cerebral palsied child's efficiency of performance under frustrating conditions. It cannot be stated with certainty that the incentive conditions would have similar consequences in the performance of a task that is learned less rapidly and with greater difficulty. We are, therefore, limited in what we can say about the effects of incentives on the learning that occurs in the course of treatment since a large number of the motor tasks which are taught in the departments of physical and occupational therapy involve long periods of learning. This is certainly true of the self-help skills.

In addition, it is possible that a more complex motor habit might be more susceptible to disruption under frustrating conditions than the simple habit of the present experiment, since the complex habit would be less easily overlearned within a short period of time. The use of more complex motor tasks in further experimentation would permit the drawing of broader inferences regarding the advisability of modifying hospital training procedures.

Certain conclusions, however, regarding hospital evaluation and training procedures may be derived from the present study. It is apparent that the constant use of verbal praise produces little modification in motor behavior; material incentives, although initially effective, may decline in reinforcement value if used repeatedly. Occasional variations in the incentive conditions used during training would seem to provide the increments in the level of motivation necessary to facilitate the cerebral palsied child's learning of those complex motor tasks which represent the goals of treatment.

There is an added diagnostic usefulness suggested by the results of the study. The fact that handicapped children often reach behavioral plateaus in learning specific skills poses a diagnostic problem. Are these plateaus caused by lagging motivation, a physiological limit based upon physical disability, or a period of "incubation" in which more complex motor patterns are being integrated? Variations in training procedures, through the use of material incentives during such periods, could help the therapist to

determine whether motivational factors are contributing to the failure to make further progress in treatment.

There is a final, broader implication suggested by the study. The results of this investigation are in substantial agreement with the results of other learning studies of a similar nature with non-handicapped subjects. Although there are very few studies of the learning processes of cerebral palsied children, there is available a large storehouse of empirical data on the facilitation of human verbal and motor learning through the manipulation of a wide variety of experimental conditions and techniques. Such procedures offer potential suggestions for modifying the training methods used in the treatment of cerebral palsied patients to induce more efficient and more rapid acquisition of those skills which are necessary for the social and physical growth of these handicapped children.

Summary

The present study sought to evaluate the effect of success and failure in securing material rewards on the cerebral palsied child's speed of performance on a pre-functional type activity. Twenty-five cerebral palsied children were required to place pegs into a series of holes on a wooden pegboard for four trials daily for fifteen days. Five groups of subjects were used: (*a*) Neutral group (N) served as a control group and was motivated throughout by verbal praise alone; (*b*) Success-Reward group (SR) was motivated by verbal praise plus the attainment of candy rewards; (*c*) Failure-Reward group (FR) was distinguished by verbal reproof and loss of candy rewards. The SR and FR groups were trained under "neutral" conditions for days 1-3, 7-9, and 13-15 and under "success" or "failure" conditions respectively for days 4-6 and 10-12. (*d*) Prolonged Success-Reward (PSR) and (*e*) Prolonged Failure-Reward (PFR) groups were tested under prolonged "success" and "failure" conditions (days 4-12). Speed of performance was the response measure employed.

The results were as follows: (*a*) N group subjects showed little modification in performance throughout the practice trials. (*b*) Both SR, FR, PSR, and PFR subjects improved in performance during the "success" and "failure" trials, but these effects did not generalize to subsequent N-trials.

The implications of these results for treatment procedures with cerebral palsied children are discussed.

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